THE

AMERICAN

JOURNAL OF PSYCHOLOGY

EDITED BY

G. STANLEY HALL

VOL. III.

WORCESTER, 1891

E. C. SANFORD, Publisher

PRESS OF P. S. BLANCHARD AND COMPANY
WORCESTER

THE AMERICAN

JOURNAL OF PSYCHOLOGY

VOL. III JANUARY, 1890 No. 1

THE INSANITY OF DOUBT.

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INSANITY of doubt is a form of mental disturbance which is brought about by certain disturbances of the psychical processes, to which the various names of insistent or fixed ideas or imperative conceptions have been given. The imperative conception or representation (*Zwangsvorstellung*) plays as important a part in the genesis of the insanity of doubt as the delusion does in the genesis of paranoia. Therefore this form of mental disturbance has often been termed the "malady of fixed ideas," and before studying it, these fixed ideas or imperative representations must be considered.

Westphal defines them as "those representations which enter into the foreground of consciousness without and even against the volition of the individual affected, who, in other respects, is still possessed of an intact intelligence. They are not brought about by any affective or emotional condition. They cannot be dispelled. They prevent the normal current of ideas. The patient recognizes them as abnormal and foreign, and opposes them with his entire consciousness." Although this definition serves in many cases, it excludes too much. The mental obsession by some overpowering emotion cannot, of course, be classed in the same category as the

ordinary imperative representation, but, nevertheless, the ordinary representation is not always free from some affective or emotional element. Wille, moreover, points out that in certain cases the intelligence does not remain intact.

In this instance, as in many others, hard and fast lines have been drawn which are not justified by the facts. As will be shown later, the boundaries of the imperative conception or of the insanity of doubt itself are by no means rigid. Insanity of doubt shades off, with all gradations, from healthy mental action on the one hand to the more pronounced types of mental disease on the other.

Imperative representations in a mild form are not uncommon in health. We all of us know how a phrase or a tune sticks in the mind against our will and often to our annoyance. After an evening at the card-table it sometimes happens that the combinations of the cards will follow me to bed, and persist in my mind for some time before sleep comes, and the same is true of other games. Another form, also common in health, is the impulse to suicide which every one feels, especially in the impulse to jump from high places. Not long ago I heard of a young man who, knowing nothing previously of such impulses, was suddenly forced to jump from a height of some thirty feet. He fortunately landed in soft earth, and, on reaching the ground, had not the slightest idea why he jumped, except that he "had to." Others have impulses occasionally to perform some absurd act, in violation of the social proprieties. These impulses are transitory, and are excited only by the presence of an opportunity for gratifying them. Impulses to other overt acts, murder, arson, and the like, are much less common in health.

From these slight and common forms of imperative representations the transition is easy to the more severe and longer-continued yet still transitory forms, such as are seen in cases like that reported by Luys, where a young accountant, after very severe work and fatigue, found himself involuntarily repeating his calculations. "The cerebral machine had been going with too much force to stop," and this involuntary toil was continued for several weeks before the patient recovered.

These forms arise from the exhaustion of the healthy brain; in other cases we have to do with the morbid action of an invalid brain, and here the imperative representations may be permanent, and give rise to much more serious conditions; they then become the true pathological dominant ideas which form the basis of the insanity of doubt.

As an example of these imperative representations, I will cite the case of Mrs. R., a lady of considerable intelligence and fair education, a public reader, aged 46, who consulted me in April, 1886. There was a marked psychopathic heredity; one aunt had the fear of contamination, another believed she had committed the unpardonable sin. The patient herself had always been nervous and a victim of migraine. For six or eight months she had had much headache, "a distressed feeling at the base of the brain," and other neurasthenic symptoms. In addition she was impressed by the idea that everything was corruptible and transitory; when she saw anyone she recognized all the anatomical details, bones, muscles, blood-vessels and nerves, she could not help seeing them and thinking of them; and she constantly thought of the connection between mind and body. She recognized the foolishness of such thoughts and realized the danger of persisting in them, yet she was utterly unable to control them.

Griesinger, who was one of the first to call attention to this condition, cites several cases, among them one of a lady who constantly questioned herself as to the why and wherefore of everything. "Why do I sit here? Why do men go about? What does this chair signify? Why do men come into being? Why are there men? " and similar questions. Another of his patients was continually questioning "why this man was so large; why he was not as high as the room; why men are only as large as they are; why they are not as large as houses; why there are not two suns and two moons, etc." One of Ball's patients believed that he had vanished, and that all about him was unreal, and constantly questioned himself about it, having an absolute loss of the feeling of identity. Buccola reports a case from Tamburini's clinique, where the patient had to know the course which bank-notes took after they were issued. Legrand du Saulle tells of a

woman who had the idea that some one might fall from a window into the street when she went out, and she constantly put questions to herself in regard to the results of such an accident. Another of his patients questioned about colors, why grass was green; why the sky was blue, etc. Höstermann tells of a man who was constantly tempted to insult the crucifix by some blasphemous act, and cases similar to this fill the old legends of the saints.

These represent the early or rather the simpler states of imperative representations. When the idea becomes still more insistent it forces the victim to perform certain actions in accordance with it. Dr. Johnson's trick of touching the posts and of entering the room with one foot always first are well-known examples of this. One of Ball's patients, remembering that thirteen was an unlucky number, next thought that it would be dreadful were God thirteen, and, to avert this, he constantly repeated "God thirteen, infinity thirteen, eternity thirteen." Hammond tells of a woman who had to search all parts of her room repeatedly lest detectives should be hidden there. Westphal cites the case of a man who began to speculate about paper, then he thought that he might commit some crime and write his confession on paper which might be found and put in evidence against him; thus he was led to cherish every scrap of paper to avert this disaster. Baillarger reports the case of a man who, if any woman whom he saw was pretty, was impelled to find out certain facts about her, her age, antecedents, manner of life, etc. If he was told that she was not pretty he had no need of this information. One day he left Paris for a distant city, and, on arrival, he asked about the ticket-seller at Paris. His companion unguardedly said that he had forgotten to look at her, and so they had to return to Paris at once to settle the matter. Charcot and Magnan have reported a case of "onomatomania," where the patient feels the necessity of recalling some word, and can get no rest until he has done so.

Wille classifies imperative representations as either absurd, senseless or utterly foolish, or entirely natural and comprehensible, but false. As an example of the latter class

he mentions a lady who was beset by the idea of her husband's infidelity, although she firmly believed in his fidelity.

Westphal divides the imperative representations into three classes; the first, where they are merely theoretical and have no influence upon the actions; the second, where the patient is compelled to perform various acts by reason of his dominant ideas; and the third, where idea and act are so bound together as to give rise to the so-called impulsive acts.

Tamburini's classification is similar:

1. Simple fixed ideas, insistent ideas proper, in which the anomaly of ideation is limited purely to the field of intellectual operations, a field purely theoretical, without being manifested externally or passing into action (metaphysical insanity, insanity of calculation, first stage of the insanity of doubt.)

2. Ideas accompanied by feelings of fear and by an emotional state of anxiety. These ideas may be more properly termed emotional ideas, in which, as a necessary consequence, there is a passage to action, imperative acts (second stage of the insanity of doubt, delirium of touch, mysophobia, etc.)

3. Ideas which can more properly be called impulsive, in which the idea so penetrates and unites with the impulsive act that it is very often of a grave and dangerous nature (impulsive ideas, homicide, suicide, etc.)

These classifications I have cited for convenience, and I shall return to them later. At present we must discuss the pathogenesis of these representations.

Consciousness is the sum of present sensations, including representative and re-representative sensations. In other words, at any given moment certain sensory cells in the cerebral cortex are actively engaged in performing their functions, that is, they are in a state of active stimulation; while other cells are either totally inactive or in very feeble activity. Thus, as I write, certain sensory cells that receive impressions from the sight of the objects about me, from the noises of the street that come through my window, and from the contact of the objects near me, certain motor cells that hold the body in position and preside over the movements of

writing, and certain more complex intellectual cells or combinations of cells in which are stored up certain ideas, all these cells are in a state of functional activity. Furthermore I am conscious that certain other sensory cells are ready to act, being now slightly stimulated by associations with the cells in present activity, and, were I to stop writing, they might take on more active functions and inhibit the action of the former set of cells. The idea that this paper must be written is, for the present, the dominant idea, the imperative representation which inhibits the action of the second group. In the healthy brain the sway of such a dominant idea is usually temporary. It arises from association or from external impressions, and may be replaced by some other idea with more or less ease. At present, with no urgent need of finishing writing, it would be a very simple process to stop,—the entrance of a patient, a certain weariness of writing, or the attraction of a novel could easily bring about a cessation of my work, and there would be merely a dim idea in the background of consciousness that the duty was still to be performed.

Now in the healthy brain, as we all know, there are many ideas more or less present to our consciousness, which have no effect upon our actions and but little upon our thoughts. Among them are the feebly insistent ideas of which I have already spoken. Their genesis cannot always be easily traced; they may be re-representative ideas excited by some obscure association, or they may arise from external impressions. In the "invalid" brain the same processes are going on, but here some group of cells, some "ideational centre," has been aroused by some pathological process to unwonted activity. The idea may be any of the absurd ones already cited. In each case that individual group of cells continues to act, it dominates consciousness, and inhibits the action of other cells, and finally the nervous energy extends to the motor cells, and produces a discharge. The patient performs some act in accordance with his idea. "In the malady of fixed ideas," says Buccola, "the anomaly of the association of ideas is due to the anomalous functioning of a few groups of cells, which, not diffusing their energy, vibrate with such

preponderance as to impede, as we say, the contemporaneous and active manifestation of the other groups of the cortex, with which they ought to be in harmony to impart to the mind a sound and perfect tone."

I do not wish to be considered as thinking this condition akin to epilepsy (oddly enough one of Griesinger's patients had had convulsions), but there is a curious analogy to be drawn between the victim of the malady of imperative representations and that form of epilepsy described by Hughlings Jackson, which is due to organic brain disease. Some of us may have had the opportunity of watching the victim of the latter affection during a seizure. He is perfectly conscious of his surroundings, he is aware and he tells you that a seizure is coming on, he feels the signal symptom, the sensory aura in his hand, he watches the muscles of the arm pass into a state of tonic and then of clonic spasm, and, although he knows everything that is going on, it is as much beyond his control as are the movements of Jupiter's moons. So it is with the victim of the malady of imperative representations. He knows that he has a dominant idea that he is in danger of contamination, he recognizes that it is utterly absurd, but yet that idea dominates every other in his consciousness, and finally is expressed by repeated acts of purification, which often he is as powerless to control as the epileptic is his convulsions.

The very curious case reported by Berger is of interest in this connection. The patient, who wrote out a full account of his mental symptoms, had paroxysmal attacks, beginning with a period of metaphysical quibbling (*Grübeln*), and passing to a state of double consciousness, where the psychical processes on one side were calm but on the other were of a tumultuous character. In addition to the psychical symptoms the face became flushed, and there was a profuse sweating, and at times symptoms of motor irritation, contraction of certain muscles. One of these attacks came on in sleep and was dreamed of. Berger, however, although recognizing the analogy between this and epilepsy, opposes the idea of any connection between the two affections—an opinion in which he is sustained by Westphal.

The insanity of doubt is based upon imperative representations, but, as will readily be perceived, it is connected with only a portion of these representations. The mild insistent ideas which occur in the healthy brain and the insistent ideas resting largely upon an emotional basis which are common in melancholia are to be excluded on the one hand. The third class of representations in the classifications of Westphal and Tamburini, where idea and act are so bound together as to the so-called impulsive acts, belongs to the class of impulsive insanities. Furthermore, the imperative representation has certain connections with delusions which will be spoken of later.

This form of insanity was recognized before we had any clear ideas about the imperative representations upon which it is based. Esquirol[1] reports the case of a girl who feared lest she had carried away something valuable from the place she had visited, and therefore undertook endless brushings and ablutions to prevent it. It is commoner in women and among the more intelligent classes, and is seen perhaps more frequently outside of an asylum. The imperative representations upon which it is based may develop suddenly or gradually, and finally they dominate the patient's whole existence, inhibiting all other forms of thought or action. After a time the patient may be compelled by them to perform certain acts, often of an absurd character. He may be aware of his situation and realize the unreasonableness of his ideas, but all to no purpose. Hence the affection is sometimes termed paralysis of the will. There is usually but little emotional disturbance, and delusions are not very common. The case rarely terminates in dementia.

Ball has classified the different clinical types of the insanity of doubt as follows:

1. The metaphysical, where the patient constantly questions himself in regard to transcendental problems, God, eternity, and the creator.

2. The realistic, where the patient questions about less important matters, why men are not as large as houses, why there is but one moon, etc.

[1] Esquirol. Des maladies mentales, ii, 63.

3. The scrupulous, where the patient is in constant distress lest he has done something he should not, and therefore he has to repeat and re-repeat every act or perform many foolish and trifling acts to avert the consequences of wrong-doing.

4. The timorous, who fear to compromise themselves, and take endless precautions lest harm should come.

5. The calculating type, where the patient must count or multiply everything.

6. The patients who fear contamination, who shrink from contact with external objects, and are compelled to perform endless ablutions (*folie du doute avec délire du toucher*, mysophobia).

Emminghaus has given a classification which seems more comprehensive, making three principal groups:

"1. Fixed ideas in an interrogative form, a marked necessity of questioning; which comprises the so-called, 'mania of why,' metaphysical insanity, (*Grübelsucht*, Phrenolepsia erotematica), and the first stage of *folie du doute*, (Meschede has shown that this morbid questioning is always purposeless and about useless things.)

"2. Fixed ideas of multiplication, or morbid necessity for calculating; arithmomania, insanity of calculation.

"3. Fixed ideas with anxious hypotheses; which comprise agoraphobia and the allied forms of morbid fears, and the second stage of *folie du doute*."

Neither of these classifications is satisfactory for the simple reason that the imperative representations which form the basis of the insanity of doubt are of so endless a variety as to render any attempt at classifying them nugatory.

Legrand du Saulle, to whom much of our knowledge of one of the forms of insanity of doubt—*folie du doute avec délire du toucher*—is due, has divided the course of the affection into three stages. In the first stage the patient is susceptible, exacting, dreamy, egotistical and timorous, yet in full possession of his reasoning powers. He is filled with morbid thoughts, he begins to inquire into the reason for every trifling thought, or act, or object about him. With that comes a lack of confidence, a distrust of his own powers, a need for verifying

everything he does, of re-reading everything he writes, a constant repetition of words and acts, and an exaggerated scrupulousness in the most petty actions. In this stage the reasons for his scruples and his actions are often concealed. It corresponds to the first division of the imperative representations in the classification of Westphal and Tamburini.

"This period," says Tamburini, "is ordinarily distinguished by the spontaneous, involuntary, and irresistible productions of some series of thoughts upon indeterminate, theoretical, and sometimes ridiculous subjects, without any illusions or hallucinations. This series of thoughts is brought to the patient's consciousness with interrogations, demands put continually to himself, a profound and constant sentiment of doubt, a species of monotonous rumination, obstinate and oppressing him by the same ideas, and sometimes with a mental representation of certain images which excite persistent pre-occupations. The sole external effect of this inward struggle is merely the necessity of frequently repeating certain acts, upon which the doubt still extends without ever being satisfied or convinced. Therefore the patients are in a state of continual inward hesitation, they are powerless to subtract this incessant labor from their thoughts, which therefore never arrive at any definite result; they are disquieted, impatient, and always plunge still deeper into a struggle which is fatally sterile; therefore they become gloomy, susceptible, egotistical, and exacting. Lacking confidence in themselves, they verify numberless times whatever they do, control whatever they say, read and re-read whatever they write, and take a quantity of precautions for every act which they perform. The ideas by which their mind is tyrannized vary according to the persons, their education, the environment in which they have lived, etc. Some question continually about metaphysical subjects (so-called metaphysical insanity), about the existence of God, creation, religious dogmas, the more general and fundamental theorems of physics, mathematics and other sciences, and sometimes about futile and inconclusive arguments; others are obliged to multiply all the objects they see or think of (insanity of calculation); in other cases the patient is tormented by the doubt that he has not done a

thing well, he has not counted money right, or concluded some negotiation properly, etc., and he is obliged to repeat the same act again and again, or else the doubt and pre-occupation return (insanity of doubt proper). In this period the patients usually conceal their trouble or confide it only to the physician or some intimate friend." Legrand du Saulle, however, places the dividing line between the first and second stage at the point where the patient begins to reveal his doubts. In this stage Westphal thinks that there is little or no emotional disturbance, except as it may arise secondarily. When the patient confides his trouble to anyone, however, he is in urgent need of another's will to enable him to overcome his dominant ideas, and to reassure him of his doubts. The manifestations of his questionings or of his ideas are often paroxysmal. Wille attempts to draw the line between sanity and insanity at this point, where the imperative representations are transformed into imperative acts. In the same way the man with hallucinations is accounted sane as long as he perceives his hallucinations to be such. Although legally this distinction is of value, it does not affect the case in any other way. Each man has an unhealthy brain, and the distinction is merely one of degree.

In the second stage of the insanity of doubt the patient begins to reveal his distress to all his friends, to give prolix recitals of his doubts, to put endless questions, and to require constant re-assurance. This for a time may relieve his perplexity, but it soon returns. There are often periods of distinct excitement attended with or preceded by praecordial or epigastric distress. The suffering becomes more intense, and emotional conditions become more pronounced. In mysophobia the ablutions become constant; it takes hours to make a single toilet. Cases of doubt are common, and both in this and in the first stage remissions are often noted. "This period," says Tamburini again, "which is usually initiated by the urgent need of revealing the patient's sufferings and giving long descriptions of them, is characterized essentially by the fear of touching certain or all objects, fearing to be soiled or poisoned, or injured in some way; the patient avoids touching them, or provides himself with gloves, hand-

kerchiefs, etc.; if he be forced to touch the objects dreaded he has palpitations, anxiety, cold sweats, and sometimes convulsive phenomena, which enter upon the scene and may even go on to syncope; the patients call these attacks their crises. This fear often originates from an instinctive aversion and dread of certain animals, rats, cats, or dogs, and the dread of the latter may even reach the degree of true terror, by exciting the idea of rabies, and it generally compels the patient to perform all the characteristic acts of mysophobia. . . . . The strange and characteristic acts performed by these patients are accompanied by continual monologues and doubts, if the washing has been sufficient, if every trace of filth has been removed, if they have touched new soiled objects, etc., but not content with their own affirmations they seek the assurance of others and oblige the persons about them to repeat certain stereotyped phrases which alone have the power to re-assure them for the moment. Withal they never succeed in being truly convinced and satisfied, since the doubt always re-appears with equal force and insistence."

Finally the patients lose confidence in their assurers. They still see the unreasonableness of their doubts, but the doubts have still greater dominion over them. The doubts are constant instead of being paroxysmal, the victims shut themselves in their houses or in their rooms, and live in their ideas and fears. Their anguish increases, "they are a prey to continual agitation, they do not read or write, and pass the greater part of their time in the midst of timorous irresolution and vague apprehensions, which keep them in a state of almost complete inertia. They are easily fatigued merely from speaking to others, while they often soliloquize in a low voice, or move only the lips with a low whisper; yet in spite of these symptoms, which would seem to indicate a complete weakening of all the mental functions, they never, or hardly ever fall into true dementia, remaining in this state unchanged for years, to the end of their sad lives." (Tamburini.) Here the mysophobist neglects his person, seldom changes his linen, and sits clothed in rags.

Such is the accepted picture of the stages of the affection and its onward progress, but it seems questionable whether

there is any true progress through the various stages. That all these classes exist is not disputed, but it is certainly wrong to say that because a patient has mysophobia, and performs acts of purification, he is therefore in a more advanced, and consequently in a more hopeless condition than a patient who simply questions.

In order to get a clearer idea of the perversion of the mental processes in this affection, we must refer to the formula of thought presented by Mercier.[1]

Mental relation		Environmental relation
a		A
⋮	corresponds with	⋮
b		B

In health we find that our concepts of the relation $a:b$ correspond perfectly with the environmental terms, $A:B$, or if not, the process of adjustment being intact, we can bring them into harmony. Thus the mental relation "a is b" is compared with the environmental relation, "A is not B," and the adjustment may be made at once, the mistake is noted. In the delusions of insanity, however, the disordered process is in the process of adjustment itself, so that correct thought becomes impossible; the patient can no longer see that the mental relation is out of harmony with the environmental relation, that "a is b" differs from "A is not B." Now the abnormality of the thought process in *folie du doute* lies between these two. In health the want of adjustment is detected at once, and need not be repeated. In the delusion the want of adjustment cannot be detected, no matter how often it is repeated. In *folie du doute* the want of adjustment is perceived, but not realized; it is apprehended, but not comprehended; the victim must compare and re-compare, and although he sees the lack of adjustment, he is never sure of it. The accompanying scheme, modified from Mercier, will show this point more clearly, the bracket pointing out the point of disturbance:

[1] Mercier, The Nervous System and the Mind, p. 251.

Mental relation			Environmental relation	
Mistake	a : b	corresponds with	A : B	Can be corrected by adjustment.
Insanity of doubt	a : b	corresponds with	A : B	Not permanently corrected by adjustment.
Delusion	a : b	corresponds with	A : B	Cannot be corrected by adjustment.

To take a concrete example: the healthy man gets his hands dirty and duly washes the dirt off, or, if he be a surgeon about to do a laparotomy, he washes his hands with the special precautions of disinfection; the mysophobist, recognizing not only the fact that his hands are now dirty, but the possibilities of dirt, is not satisfied with washing them once or twice, but must repeat the process indefinitely; the victim of the delusion believes not only that his hands are dirty, but that no washing can cleanse them, that he is a source of corruption to the world.

The imperative representation is thus seen to occupy that position between the normal ideational process on the one hand, and the delusion on the other; and its malady, *folie du doute*, stands between the healthy reasoning process, and paranoia. Again it must be insisted that there is no fixed line of division. We have seen how the healthy insistent idea may pass by all degrees into the insane insistent idea, and the insane insistent idea may finally cease to be recognized as false, just as the hallucination finally ceases to be recognized as false, and the idea becomes the delusion. Thus a patient of Meschede had finally hallucinations and delusions of persecution; one of Wille's patients, who had the insistent idea that everything was damned, finally developed true hypochondriacal paranoia. Schüle[1] classes *folie du doute* as a disease of the defective constitution and states that part of the cases go on to delusional melancholia. Westphal classes it as an abortive *Verrücktheit*, while Krafft-Ebing[2] goes farther and sets it down as merely a variety of paranoia, *primäre Verrücktheit in Zwangsvorstellungen*, ordinary paranoia being *primäre Verrücktheit in Wahnideen*.

[1] Schüle, Klinische Psychiatrie, p. 18, 468.
[2] Krafft-Ebing, Lehrbuch der Psychiatrie, ii, p. 10.

Krafft-Ebing[1] has also analyzed these two forms of insanity, showing the common features in their development, and the distinctions between them. Paranoia and *folie du doute* are alike in the following respects:

"1. Heredity or original neuropsychopathic constitution, which can almost always be detected, and which points to original functional anomalies of the nervous centres.

"2. Slow invasion of the disease, reaching back to puberty.

"3. The primary onset of anomalies of representation, deprived of any affective basis.

"4. Representations of a strange and unassimilable character, projected from the depths of consciousness and connected with consciousness by associations, either as imperative representation or delusion as the primordial creation of a diseased brain.

"5. The typically congruous nature of ideas in different individuals, as in mysophobia or the congruous delusions (of persecution) in paranoia.

"6. The purely constitutional, but permanent and stationary character of the two affections.

"7. Neither of them ends in dementia."

They differ in these respects:

"1. In paranoia the ideas are of a delusional character, while fixed and insistent ideas treat only of simple formal alterations of the process of ideation.

"2. In paranoia the morbid ideas are soon taken up and assimilated by the consciousness, but the fixed ideas always remain more or less completely extraneous, shut out, and opposed to consciousness, which is still perfectly clear, and to the reason and the will, which are dominated by them. Hence come the pain and distress to which the patients are a prey, which arise in part from the sad consciousness of the formal disorder of ideation, in part from the nature of the fixed ideas which are almost always painful and sometimes dangerous to themselves or others, and in large part from the impossibility of getting away from these ideas and acts." Here, again, I believe that too sharp a distinction has been

[1] Krafft-Ebing, Allg. Zeitschr. f. Psychiatrie, XXXV., 1878.

made, as the *folie du doute* and paranoia evidently blend.

I have traced the growth of the imperative representation from its simple manifestation in the healthy brain to its full development in the invalid brain. The factor of doubt, which plays so important a part in these cases, has also its analogy in health. At times even in the healthy brain there will come phases of doubt, when we are uncertain whether we have properly performed some act, whether the door was locked when we left the house, or whether the letter just mailed was properly directed and stamped. A striking instance of the sort was related to me by a friend remarkably free from any psychopathic taint. It often happens that he does scientific work in the evening at the Agassiz Museum. When he leaves for the night he puts out the gas and then stands and counts slowly up to a given number until his eyes are used to the darkness, in order that he may detect any spark of fire that may have started while he was at work. This is his invariable custom, but it sometimes happens that when he goes back home so strong a feeling of doubt comes over him lest he may that once have omitted to do this, that he is uncomfortable until he returns to the museum to make sure. The act has become so automatic, probably, that the higher centres take but slight part in it, and so it is not recalled to the memory like some unusual action; but—and here is the point where the action of the healthy brain differs from the brain of the victim of *folie du doute*—when he has gone back and repeated his accustomed act, thus assuring himself of its performance, he has no further trouble, while the insane doubter must verify and re-verify and verify again, and yet at the end he is still in doubt.

Turning back to the other end of the scale, where the insistent idea approaches the delusion, where abortive paranoia (*folie du doute*) approaches paranoia, the following case shows clearly the mixture of insistent ideas and delusions, the combination between insanity of doubt and paranoia.

Margaret K., a servant-girl, unmarried and forty years of age, came to me at the Boston City Hospital in May, 1886. How much of a psychopathic heredity there was it is hard to say, for the patient knew but little of

her family; one sister, she said, was "not right in her mind," being cross and quick-tempered. The patient herself was small, rather anæmic, moderately well nourished, and was much marked by small-pox. She consulted me "because her head was upset." She was unable to give the date of her attack of small-pox, but it was during her early years. Except for that she had always been well. Her sexual desires had always been very strong, and she had practiced masturbation at various times. As a girl she had allowed various men to take liberties with her, but she had never permitted coitus. For fifteen years or more she has been a victim to various forms of doubt, and she has had sundry imperative representations. She has had the belief that her employers were wronging her about her wages, and that she has had money which has disappeared. She is unwilling to say anything about her losses because she does not know whether she has actually had the money; she thought she had it, but she is not sure; she cannot be sure that anyone took it, she thinks they did, but she is not sure; someone offered to restore the money to her, but she was unwilling to take it, because she was not certain whether it was taken, or whether she ever had it; the restoration might be to try her, and it might cause her injury if she accepted it. She thinks the money that disappeared was stolen, but she does not want to say that it was, neither will she state the amount. If she suspects anyone, and listens, she thinks she hears voices talking, but of this she is doubtful. She is disposed to think everything sinful, she is disturbed about the future life on account of her sins, and fears that the dead may return. When it is suggested that the dead don't want to return from heaven and can't return from the other place, she says "Yes, I know it; they can't come back, but yet I think about it." On the next visit she returns to the same subject as before. She says she has been careless and talked about her neighbors, which is a sin. When asked if she had ever said anything bad about them, she says, "No, I don't know that I have, I don't remember, but sometimes I think I might have." She wants to tell her faults over and over again at the confessional before she is satisfied. She is afraid if in a lonely street in the dark lest some one should kill her. She thinks men want to abuse her, as she has seen them with their clothes unbuttoned. At another time she said she did not think she had ever indulged in coitus, but she couldn't be sure. One day she asked if there was not such a thing as sin with a dog; she had heard of it and was anxious about it; she had never committed it, at least she thought she had not, but sometimes it seemed as if she might have. When she went to bed she had to have the clothes arranged in a particular fashion as a protection; if she did not she thought it was sinful. It was a sin. too, if she did not lock her door. All this and more would be repeated at each visit, and when she was assured that she had done nothing wrong, that these ideas were all nonsense, and she need not worry about them, she would say, "Yes, I know it, I don't think I have done anything wrong, and yet sometimes it seems as if I

had." As might be expected, her doubts and her imperative conceptions continued, assurances to the contrary having but slight effect, and after a time she passed from observation.

Insanity of doubt may develop at almost any age; it is commoner among women and in the better classes, the case just cited being an exception. Among the predisposing causes are acute diseases, anæmia, masturbation, sexual excesses, overwork, anything that may weaken the nervous centres and depress their tone. The majority of writers regard it as distinctly a psychical degeneration like paranoia, and claim that the psychopathic taint and bad heredity are the chief factors in the origin of the disease. This is undoubtedly true of the severer cases, but Cowles has shown that in the milder types the hereditary taint is absent. From our study of the development of their conditions, such an opinion must be accepted. There is no hard and fast line between the fully developed insistent idea, (the pathological obsession), and the normal obsession, so that between the two must lie many cases of slighter degree, with no psychopathic taint. Moreover, the insanity of doubt has been shown to be a lesser disturbance of the mental process than true paranoia, hence the brain must be less impaired.

The following case of typical mysophobia (*folie du doute avec délire du toucher*), shows one of the milder types of the disease, although theoretically belonging to the second stage. Here there was a speedy recovery, and no special taint. In the case of Mrs. R., already cited, although nominally in the first stage, the condition was much more persistent, and was complicated with a bad heredity.

Miss G., aged eighteen, consulted me on the 16th of April, 1888. Her father and sister are "quite nervous," beyond that I could get no special history of a neurotic taint. She, herself, is a slight, anæmic underdeveloped girl, a student in one of our higher schools. For some months she has been working hard at school, and has been slowly losing strength; her appetite is poor, she has a tired feeling in the chest, menstruation is irregular. She consulted a physician, who prescribed a tonic containing iron, which she took with some benefit. About a month ago, however, she began to feel that she must use especial care in rinsing out the glass she took her medicine in, otherwise it would cause trouble. She began to be fearful of poison. She felt that she must wash

her hands with great care lest ammonia should get on them. The trouble increased, and she began to feel that she must repeat the washings in order to be sure that no poison or ammonia could get on her. If she tries to overcome the feeling she has a headache. If she neglects her washings she has a predominating idea that some one will be hurt if she does not repeat them. She was ordered to leave school, and a course of baths, feeding, and an out-door life was prescribed. She was assured that no harm could come to her or to any one if the washings were neglected, and she was urged to resist any inclinations to yield to these involuntary representations. A week later she reported improvement, she can overcome her feelings better and they are less strong, but she still has the feeling that she has been careless, she knows she really has not been careless, yet the doubt continues. The treatment was continued, further encouragement and assurances were given her, and two weeks later, on the 7th of May, she reported that she had no more trouble.

Some years ago I had the opportunity to observe at the Boston Lunatic Hospital a patient who was apparently in the third stage of insanity of doubt. The case has already been reported by Dr. Boland,[1] so that I will refer only to certain points in the case. There were certain fears of wrong doing, and the patient had to repeat her words and acts five times to be sure that they were right. These repetitions weary her so much that she will sit for hours motionless, dreading to move lest the act should require repetition. She becomes somewhat depressed, and from this dread of the repetitions, is careless of her dress. At the first glance her expression and attitude are that of a patient with melancholia attonita. In spite of her being apparently in the third stage, she has recovered from three similar attacks, (I saw her in the third) and is now undergoing a fourth. As a matter of fact insanity of doubt may begin with or very soon pass into any stage, and any stage may be recovered from.

Although, however, many of the cases of insanity of doubt have no psychopathic taint behind them, it is a curious fact that imperative representations (of a non-affective character) are rarely met with in neurasthenia. On going over one hundred consecutive cases, I found such symptoms noted in only one. Neurasthenic patients are timorous, doubtful, and need constant re-assurance, but true insistent ideas are rare.

[1] Boland, Boston Med. and Surg. Journ. 9 April, 1885.

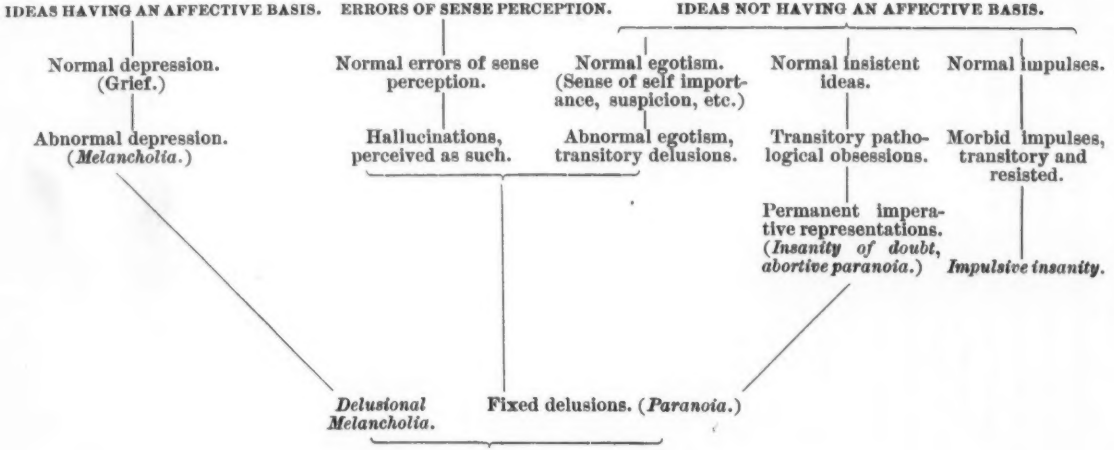
Many authors class the various morbid fears, agoraphobia, claustrophobia, etc., with the insanity of doubt. The classification seems erroneous. The victim of agoraphobia has a sudden attack of morbid fear under certain external conditions. It rarely happens that his fears have anything to do with previous processes of ideation, and it is still more rare to find the slightest trace of anything like an insistent idea. There is rarely any element of doubt or hesitancy, but a sudden physical inability to perform an act. Agoraphobia, and its kindred affections, form a class in the intention psychoses recently described by Meyer[1], and have little to do with the insanity of doubt, although one of Krafft-Ebing's patients, who had imperative representations, had also agoraphobia. Some victims of agoraphobia, however, are haunted by their morbid fear, even when in the house, thus showing a gradation between the intention psychosis and the imperative representation.

Impulsive insanity, (homicidal mania, etc.,) is so strongly differentiated from the insanity of doubt, that, although based on imperative representations, it must be put in a separate group. In the insanity of doubt there is an imperative representation, with incessant speculation and hesitancy, and finally numberless petty acts and an inability to perform the necessary duties of life. In impulsive insanity there is an imperative representation leading to the performance of a single act; this is resisted for a time, but finally the impulse becomes irresistible, and the discharge takes place. In the one there is paralysis of volition, in the other a convulsive discharge.

The following table will represent the genesis of the various representations and the relations of certain forms of insanity to the insanity of doubt:

[1] Meyer, Arch .f. Psychiatrie, xx, 1888.

TABLE I.


IDEAS HAVING AN AFFECTIVE BASIS.
ERRORS OF SENSE PERCEPTION.
IDEAS NOT HAVING AN AFFECTIVE BASIS.
Normal depression. (Grief.)
Abnormal depression. (Melancholia.)
Normal errors of sense perception.
Hallucinations, perceived as such.
Normal egotism. (Sense of self importance, suspicion, etc.)
Abnormal egotism, transitory delusions.
Normal insistent ideas.
Transitory pathological obsessions.
Permanent imperative representations. (Insanity of doubt, abortive paranoia.)
Normal impulses.
Morbid impulses, transitory and resisted.
Impulsive insanity.
Delusional Melancholia.
Fixed delusions. (Paranoia.)

It may be added that in insanity of doubt certain physical symptoms are noted: Headache, pain, præcordial distress, tremor, vertigo, tinnitus, vaso-motor disturbances, loss of appetite, insomnia, etc.

The prognosis is regarded by almost all writers as very bad; but the majority of them look upon insanity of doubt as a psychical degeneration. Spitzka alone says that many of the mild cases get well in three months. From what has been already said it is plain that Spitzka's view seems more correct. The important factor in prognosis is the existence of a hereditary taint. In well marked cases, where this exists, the outlook is, of course, bad.

Beside the ordinary tonic treatment, rest, forced feeding, etc., stress must be laid upon mental and physical gymnastics. The necessity for doing certain acts in regular repetition, for repeated efforts of volition, such as are required, for instance, in using the chest weights, may have a beneficial result on other mental processes.

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See also the treatises of Krafft-Ebing, Emminghaus, Spitzka, Ball, Maudsley and Hammond. Reports of single cases are omitted.

THE EFFECT OF FATIGUE ON VOLUNTARY MUSCULAR CONTRACTIONS.[1]

WARREN P. LOMBARD, M. D.

In March, 1889, I had the good fortune to spend three weeks in the physiological laboratory of the University of Turin. It is with much pleasure that I take this opportunity to express my appreciation of the great courtesy of Professor Angelo Mosso and his assistants. It was only by their advice and aid that I was able to make the research recorded in this paper.

Apparatus and Method.

The research was begun at the suggestion of Professor Mosso, who proposed that I should continue Dr. Maggiora's[2] work on the fatigue of voluntary muscles, and who placed the apparatus which Dr. Maggiora had used entirely at my disposal. This apparatus, which is very simple and satisfactory, has been described at length by Professor Mosso—*Li Ligi Fatica Studiate nei Muscullo dell Uomo*, R. Academia dei Lincei, 1889.

All the experiments were made upon men, and most of them on the flexor muscles of the second finger. The muscles were stimulated voluntarily or electrically, and the corresponding movements of the finger were registered.

The record was made by a pen which was carried by a little car. The car was supported by two parallel horizontal steel rods, upon which it slid with very little friction. A string, fastened by a leather loop to the finger, pulled the car in one direction, and a cord, which passed over a pulley to a weight, drew the car in the opposite direction. Thus, when the muscles contracted, the finger was flexed and the car was drawn forward, and when the muscles relaxed, the weight caused the finger and the car to return to their original posi-

[1] This paper was read before the Physiological Congress at Basel, Sept. 29th, 1889.

tions. The movements of the car were recorded by a pen on the horizontal drum of a Baltzar kymographion.

The subject was seated during the experiments. The hand and arm were securely fixed on a convenient rest, and, in spite of the violent muscular contractions which were often required by the experiments, made no movement of a kind to influence the record. This question was carefully studied. Also the action of the finger was watched, to see that all the joints moved with each contraction, in other words, that all the muscles which assist to flex the finger were contracted.

Discovery of the Periodicity.

As the first step of the proposed research, it was necessary for me to ascertain the normal curve of fatigue of my muscles, because Dr. Maggiora had found that this varies in different individuals. In these experiments, I voluntarily contracted the flexor muscles of the second finger of the left hand every two seconds. The signal was the sound made by the interrupter of an electric clock. Each contraction was the strongest possible, and, as the weight was three kilograms, the muscles soon began to weary. The drum revolved slowly and the following curve of fatigue was recorded:—

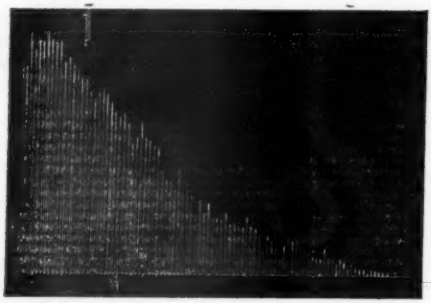


FIG. I.

Several records closely resembling this were obtained. On the second day, however, the work was continued in one experiment longer than usual, because I was determined to fatigue the muscle so completely that no contraction should

be possible. After 110 seconds of continuous work, I could hardly stir the weight, and thought the experiment nearly at an end. To my surprise, however, I began to recover the lost power, and during the next half minute each of the succeeding contractions was higher than the one which had preceded it. The effect of fatigue then began to manifest itself again, and the contractions became smaller. I concluded that I had made a mistake, that I had not exerted all my will power before, and I determined for the rest of the experiment to do my best. As the contractions grew smaller I threw all my energy into each attempt to raise the weight. I was conscious that, as is always the case during violent muscular exercise, I was contracting many muscles of the body, and that my face was flushing under the strain; nevertheless, the contractions became gradually less, and I supposed that I had finally succeeded in tiring out the muscle, when, to my astonishment, I began to recover my power a second time. The contractions became stronger, reached a maximum and fell, only again to recover. In short, for some inexplicable reason, during the twelve minutes that the work was performed, the ability to voluntarily contract the muscles with sufficient strength to raise the weight, decreased and recovered five times. During the intervals of decreased strength the power was almost entirely lost, while during the periods of recovery, the force was equal to that shown half a minute after the beginning of the work. Fig. II, Plate I, is a better witness than any words.

The recovery of power which I observed in this and in similar experiments interested me so much that I gave up the intended research and devoted my time to studying its nature and cause.

Constancy of the Phenomenon.

A few days of work showed that the observations which have been described were not exceptional, but that in my case, at least, the periodic loss and recovery of force could be found every day and at all times in the day; on the muscles of both arms, and on the extensors as well as flexors; with weights of ½, 1, 2, 3 and 4 kilos.; and when the muscles were contracted at intervals of 1, 2 and 4 seconds.

Experiments upon Others.

Unfortunately, lack of time prevented extended experiments upon others; nevertheless, the power to voluntarily contract the muscles was seen to vary in a like manner in the case of two other strong, healthy men. Fig. III, Plate II, is a reproduction of the record obtained from one of these experiments.

The phenomenon is, therefore, normal. It is, however, far from sure that it can be found well marked with all men. I failed to obtain it in a few experiments which I made on six other men, although in some of them suggestive irregularities were seen. As has been said, the phenomenon is distinctly a result of fatigue, and, therefore, the experiments are not agreeable. Men are very differently constituted, both as regards their ability to concentrate their efforts, and to continue muscular work after fatigue has made it painful. One sees this exemplified in races, on the march, and whenever long continued and violent muscular exertion is required. I do not know that these constitutional differences have ever been satisfactorily explained, or, indeed, that anyone has a well defined idea of the physiological conditions which are essential to endurance and tenacity.

Study of a Characteristic Experiment.

In long continued experiments with weights lighter than that which was employed in the experiments recorded in Fig. II, Plate I, the alternating loss and recovery of power, though appearing later, is even more striking. Fig. IV, Plate I, records an experiment on the flexor muscles of the second finger of the left hand, with a weight of half a kilogramme. The muscles were voluntarily contracted every two seconds, and each time with the utmost force. In this case the difference between the height of the contractions during the interval in which the voluntary power was lost, and the periods when the muscle responded well to the will impulse, was very great. For the first half minute of this experiment, the height of the contractions varied from 53 to 57 mm., and averaged 55 mm. They then began to decrease in size, and at the end of 9½ minutes had fallen to 5 mm. The

change during the last half minute was very rapid. In the preceding half minute the contractions were irregular and varied from 17 to 32 mm., but averaged 24 mm., while during the last half minute they were, viz.—22, 23, 17, 19, 17, 12, 15, 11, 15, 12, 8, 6, 7, 6, 5.

From this time on the alternating intervals of loss and periods of recovery of power became well marked, as is seen in the reproduction of the curve, Fig. IV, Plate I, and in the following table.

The table records the variations in the size of the contractions during the first eleven successive periods. The size of the contractions is stated in millimeters. Each column of the table contains the contractions which occurred from the time that the power began to be recovered until it was lost again.

TABLE I.

1	2	3	4	5	6	7	8	9	10	11
6	9	6	9	7	7	12	10	10	10	12
6	10	8	22	9	6	11	18	14	10	12
8	11	23	44	7	7	10	15	10	23	15
14	17	44	47	9	9	12	22	14	42	20
11	12	46	44	11	10	29	26	16	47	34
11	26	45	46	21	10	45	44	34	47	45
14	43	46	45	26	15	47	49	42	48	46
15	41	48	45	46	20	47	47	45	50	48
27	43	42	44	47	44	39	39	47	48	45
46	42	47	37	47	46	30	30	46	45	46
48	44	40	25	33	49	13	21	44	38	45
46	45	29	14	27	40	9	18	44	38	40
34	42	20	10	13	20		10	44	36	38
38	45	10	8	11	12		6	49	14	40
42	41	7	5	8	11			48	10	38
41	36	11		7	7			45	7	40
42	30	11		6				50		30
47	25	7						50		14
42	16	5						47		8
39	10							46		
45	10							36		
47	5							40		
48	5							48		
39	4							47		
41								41		
37								48		
40								30		
33								15		
35								17		
25										
11										
8										
8										

The difference between the size of the contractions during the periods of power and intervals of weakness was remarkably constant. This is well seen in the following table, in which the highest contraction of each period is placed by the side of the lowest contraction of the following interval. The height of the contractions is stated in millimeters.

TABLE II.

Highest contraction of the period.	Lowest contraction of the following interval.
48	8
45	4
48	5
47	5
47	6
49	7
47	9
50	6
40	7
48	7
47	8
47	8
48	13
48	10
47	8
47	6
48	4
49	4

The regularity seen in this table is the more surprising when one reflects that it depended not only on the action of mechanisms within the spinal cord, of the nerves, the nerve ends and muscle fibers, but also on the ability of the subject of the experiment to give each time the strongest will impulse possible. The fact remains the same, however, that in each of the periods of recovered power the highest contraction was of about the same size, and that it was nearly as vigorous as the contractions which were made at the beginning of the experiment.

It is also noteworthy that during the intervals of decreased force the strength was lost each time to almost exactly the same degree.

On the other hand there was but little regularity in the length of the succeeding periods. Stated in seconds their lengths were, viz.—66, 48, 38, 30, 34, 32, 24, 28, 62, 32, 34, 28, 44, 26, 28, 38, 34, 26.

There was also great difference in the time elapsing before the highest contraction of each of the successive periods was

reached. Stated in seconds these times were, viz.—22, 24, 16, 8, 18, 22, 14, 4, 36, 16, 16, 4, 38, 14, 10, 14, 12, 12.

Likewise the time between the highest contraction of a period and the next lowest contraction varied greatly, viz., 44, 24, 22, 18, 16, 10, 10, 14, 26, 16, 18, 24, 6, 12, 18, 24, 22, 6.

It is unnecessary to calculate the work accomplished in each period. A glance at the curve discloses that it was not the same in any two periods.

To summarize these results one may say that nine and one half minutes elapsed before the first interval of decreased power was reached. During the succeeding ten minutes the power to raise the weight was regained and lost fifteen times. The periods of recovered power varied greatly in length. The lowest contractions of the intervals and the highest contractions of the periods were irregularly distributed. In no two periods was the same amount of work accomplished. Finally the highest contractions were of about the same size in all the periods and were nearly equal to the contractions occurring at the beginning of the experiment, though in the intervals of decreased force the contractions had almost no power.

Search for the Seat of the Changes which Produce the Periods.

When a muscle is voluntarily contracted many chains of mechanisms are thrown into action. All these chains are connected with the areas of the brain originating the will impulse. The successive links are formed by the mechanisms within the central nervous system, the centrifugal nerves, the nerve ends, and the muscle fibres. Which of these organs is the seat of the changes which cause the loss and recovery of voluntary power?

The periods do not appear until after considerable work has been performed. The greater the weight and the more frequent the contractions the sooner they occur. Indeed, they seem to be essentially connected with the fatigue of the mechanisms involved in the voluntary movement. It is well known that muscles weary rapidly if deprived of blood, and

as Dr. Maggiora has shown they recover their strength with equal rapidity if treated with massage during the intervals of repose. These facts suggest that the periods are the result of circulatory changes in the muscle.

With the hope of ascertaining the truth of this supposition I made the following experiment. I contracted the flexor muscles of the second finger, weighted with 2800 grammes, every two seconds, and each time as vigorously as possible. When fatigue had become great, and the intervals of loss and periods of recovery of force were very marked, the muscle was subjected to massage. The work was continued during the massage with the same regularity. At the end of a few minutes, the effect of the massage was seen in the flushed skin and in the fact that the muscular contractions during the intervals of decreased power were somewhat higher than before. Nevertheless, the periods continued to occur. In other words, the increased circulation caused by the massage, though slightly strengthening the muscle, did not remove the periodicity. Fig. V, Plate II, is a reproduction of the record of this experiment. The arrow marks the moment at which the massage was applied.

Another form of experiment was then resorted to, in order to see if the irritability or strength of the muscle was less at the moment that the voluntary contraction was weakest. The condition of the muscle was tested at the beginning of the experiment by a tetanizing induction current, applied at intervals of two seconds, during about half a second, the muscle raising a kilogramme at each contraction. After ten contractions the electricity was stopped, and the subject began to voluntarily contract the muscle every two seconds, and always with his whole force. When the periodicity had become well defined, the muscle was again tested with electricity. The test was made during an interval when the most vigorous voluntary effort was incapable of raising the weight. It was found that the response to electricity was about the same, and that the muscle was still capable of doing work. Moreover, although the electric stimulations were applied regularly, every two seconds, for some minutes, no recurrence of the periodicity was seen. When the electricity was dis-

continued and voluntary contractions again commenced, the periods soon returned. It is worthy of note that the periodicity did not appear immediately, however. It seemed as if the mechanism which was the seat of the changes producing the phenomena, had had an opportunity to partially recover during the time that the muscle was contracting in response to the electric irritations. The difference in the form of the record obtained, when the muscle is irritated directly by electricity, and when it is stimulated voluntarily, is well illustrated in Fig. VI, Plate II. The whole curve is the record of one continuous experiment, and contains two groups of periods, obtained when the muscle was voluntarily contracted, and, between them, the series of contractions which were called out by direct electrical stimulation of the muscle. These experiments, and others in which the muscle was stimulated by electricity every two seconds for a long time, and was seen to weary without any sign of periodic loss and recovery of power showing itself, forced me to conclude that the phenomenon did not originate in the muscle.

The nerves and nerve ends were next studied. The record of one of the experiments is given in Fig. VII, Plate I. The median and ulnar nerves were irritated by a tetanizing induction current, applied every two seconds, for about half a second, one of the moist electrodes being placed on the skin over the sternum, the other over the region of the nerves on the inside of the upper arm. The record was taken from the second finger, and the weight was one kilogramme. It was with difficulty that the most favorable point for simultaneously stimulating both nerves was found; at last, however, all the phalanges were seen to move in response to the irritation, and it was evident that all the muscles which help to flex the finger were receiving the nerve impulse.

After the muscles had contracted ten times, (see *a* on curve,) the irritation was stopped and the muscles were voluntarily contracted every two seconds, and always with all the force possible. The periodicity appeared in this case sooner than was usual, perhaps because the subject was tired, on account of the many experiments of the preceding days. After 209 contractions, about seven minutes' work, when the

periods had become very decided, the effect of electrical stimulation of the nerves was again tried (see *b* on curve); the muscle contracted less than at the beginning of the experiment, but, though the irritations were given every two seconds for nearly two minutes, no periodicity manifested itself. When the voluntary contractions were begun again the periods occurred as before.

It is worthy of observation, that, in this case, as in that already referred to, of direct electrical stimulation of the muscle the first period after the electrical stimulation was stopped was longer than those which occurred just before the stimulation with electricity, which suggests that the mechanisms which are the seat of the changes which cause the periodicity, had time, while the nerves and muscles were working under the influence of the electrical irritations, to partly recover from their fatigue. That the recovery was incomplete, was shown in the rapidity with which short periods made their appearance.

During this experiment the subject had the curiosity to try the effect of continuous voluntary contractions of the muscles. He avoided looking at the curve lest he should be influenced by it. He raised the weight as high as possible and did his best to keep it at that height. He was conscious of the loss and gain of power, but was not aware, until afterwards, that his finger had written a curve which corresponded to a silhouette of the records of the intervals of loss and periods of gain of power which were recorded when the muscles were contracted every two seconds.

The effect of electrical stimulation of the muscles was tried a third time, and it was found that the muscles contracted higher than at the beginning of the experiment, (see *c* on Fig. VII, Plate I.) The writer lays but little stress on the difference in the height of the contractions obtained with the electric current in the three observations of this experiment, because it is probable that they were caused by slight changes in the position of the electrode on the arm. The important fact demonstrated by this experiment is the absence of periods from the curves obtained by stimulating the nerves by electricity, and, that too, at a time when the periodic

variations during the voluntary contractions were very marked.

By chance, the third time that the voluntary contractions were begun coincided with the part of the period when a vigorous contraction was possible and one high contraction was recorded. Immediately after, however, the cause which produces the intervals asserted itself, and the contractions became smaller. The record looks as if part of a period had been cut off; (see the first contraction following series marked *c* in Fig. VII, Plate I.) This chance observation, which was repeated in another part of the experiment not given in the plate, is very important, because it shows, both by its shape and the time of its occurrence, that the changes which cause the periods continue after the voluntary action has ceased.

Although the foregoing experiments suffice to show that the periodic variations were of central rather than peripheral origin, I sought a method of experimentation which would enable me to form a clearer idea of the relative influence exerted on the height of the contractions by the fatigue of the muscles and the changes occurring in the central nervous system. At the suggestion of Professor Mosso the following form of experiment was adopted. The flexor muscles of the second finger, weighted with one kilogramme, were stimulated every two seconds. Two different forms of stimuli were employed, electrical and voluntary stimuli, and they were applied alternately. During the electrical irritation, the nerves and muscles were stimulated by a tetanizing induction current, one of the electrodes being placed over the sternum, the other over the muscle. Fig. VIII gives the results of a part of this experiment, and looks as if the records of the response of the nerves and muscles to electrical stimuli and to voluntary impulses had been superimposed.

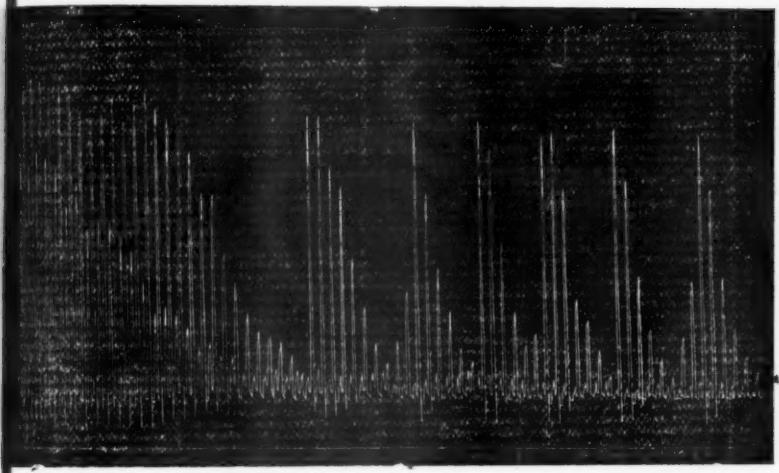


FIG. VIII.

The records of the voluntary contractions differ entirely from those written by the contractions produced by the electrical stimulation of the nerve. The voluntary contractions do not begin to decrease in size as soon, and when they commence they lessen much more rapidly. There is a moment when the response to the two forms of irritation is about the same, but the voluntary contractions soon begin to increase in height, and from this time on, the shape of the two records is as different as possible. The condition of peripheral organs, as shown by the response of the nerves and muscles to electricity, varies but slightly and irregularly, while that of the central nervous mechanisms, as shown by the extent of the voluntary contractions, undergoes marked and rhythmical alterations. The difference in the relative height of the two curves is due in part to differences in strength and effectiveness of the two forms of irritation.

These and other similar experiments convinced me that the changes producing the periodicity, do not occur in the nerves, the nerve ends, or the muscles, and that they take place in the central nervous system.

Which of the central mechanisms is the seat of these changes? The will power seemed to the subject to be unabated, and experiments showed that he was capable of contracting other muscles vigorously at the moment that he was unable to lift the weight with the finger. The result of one of these experiments is to be seen in Fig. IX, Plate I. The letter *f* marks the beginning of the voluntary contractions of the flexors of the finger, and *t* the beginning of the voluntary contraction of the extensors of the thumb. In this experiment two cords were attached to the recording apparatus; one was fastened to the second finger, the other to the thumb. The second finger was then contracted voluntarily at intervals of two seconds, each time raising a weight of 2800 grammes as high as possible. After a few minutes the periods became well developed. In one of the intervals, when the power to move the second finger was lost, the subject ceased to try to move the finger and raised the weight by voluntarily contracting the extensors of the thumb. These muscles responded well, and they were used until fatigue set in, and they in their turn demonstrated the periods. Then, at a moment when the ability to extend the thumb was lost, the work was taken up by the flexors of the finger and they were found to be capable of raising the weight nearly as high as at the beginning of the experiment.

The facts just stated prove that the loss and recovery of the ability to voluntarily contract the muscles is not dependent on changes in the strength of the will, but on alterations which take place in some of the mechanisms between the areas of the brain originating the will impulse and the centrifugal nerves. It also shows that the seat of the changes which produce the periods is different for each of the muscles, and that the change occurs in the central mechanisms which control the different muscles, independently.[1]

The successive periods, though sometimes occurring with great regularity, more frequently show many variations,

[1] Last August I made a few experiments on this subject in the Physiological Laboratory of Leipzig with Dr. Max von Frey. These experiments showed still more clearly that the will power is unabated at times when voluntary contractions are markedly decreased. The results of these experiments will be reported in full hereafter.

which prevent us from attributing them solely to a rhythmical action peculiar to the central mechanisms. See statement at bottom of page 29. In another experiment the lengths of thirteen successive periods were, in seconds, viz., 24, 28, 24, 38, 26, 28, 40, 32, 24, 20, 18, 24, 32.

In still another experiment in which the muscles were voluntarily contracted every four seconds, against a weight of 2800 grammes, the following results were obtained. The first period appeared in about fourteen minutes, and during the next forty-five minutes, forty-seven periods were recorded. The number of contractions forming a period and the number of contractions which failed to raise the weight, during the intervals of decreased power, gradually increased. These changes caused by the fatigue of the central mechanisms displayed, however, many irregularities. There were many moments when it seemed as if the periodic changes had ceased. Thus the 29th and 46th periods contained respec tively 48 and 33 contractions, instead of six or seven, the number found in many of the other periods. The following table will give a good idea of the eccentricities of the phenomenon. It states the number of contractions which occurred in each period, and the number of unsuccessful contractions during each interval. A contraction which failed to raise the weight half a millimetre was considered an unsuccessful contraction. As a matter of fact the muscle always contracted somewhat.

TABLE III.

Number of contractions in a period.	Number of unsuccessful contractions in the following interval.	Number of contractions in a period.	Number of unsuccessful contractions in the following interval.
206	0	1	1
12	0	7	1
12	0	1	2
13	0	6	0
20	0	17	0
18	0	48	4
15	1	7	1
11	2	2	1
16	1	6	2
19	0	12	3
7	3	5	1
11	4	6	1
12	3	1	1
15	0	6	5
4	4	7	1
13	2	8	7
11	1	7	3
11	7	6	3
12	7	6	6
9	2	7	4
6	4	6	5
12	?	7	0
?	?	33	3
7	2	7	1

Summary of Results and Conclusions.

I found that if I voluntarily contracted a muscle frequently, and each time raised a weight with my utmost force, the mechanisms involved in the action gradually wearied, the contractions weakened and after a time scarcely stirred the weight. If, however, I continued, regardless of the result, to strive with the whole power of my will to frequently contract the muscle, sooner or later my force began to return. The recovery, for a short time, might be almost complete. Soon, however, the power began to be lost for a second time and throughout the rest of the experiment intervals of almost entire loss of power to voluntarily contract the muscle were seen to alternate with periods of nearly complete recovery.

Not only are the variations in the strength of the contrac-

tion of the muscle wholly out of the control of the subject, but he does not even know, when he wills a contraction, whether the muscle will respond vigorously or not.

The phenomenon was observed in the case of the extensors as well as the flexors; on the muscles of both arms; with weights of 1, 2, 3 and 4 kilogrammes; and when the muscles were contracted at intervals of 1, 2 and 4 seconds.

The alternate loss and recovery of power which has been described is evidently the result of fatigue, because it is well marked only after the work has been continued for a considerable time, and it appears more quickly when the contractions are frequent, and the weight is large.

That the periodic loss and recovery of voluntary control over the muscle is not due to nutritive changes in the muscle itself, is shown by the fact that massage, though strengthening the muscle, does not do away with the periodicity. Moreover, they do not seem to be dependent on variations in the irritability of the nerves, the nerve ends, or the muscle, because at a moment when a voluntary contraction is almost impossible, the muscle responds well either to direct electrical stimulation, or to electrical stimulation of its nerve. Moreover, periodic variations of the force of the contractions are never seen in experiments in which the muscle or its nerve are frequently stimulated with electricity. Further, if a muscle be voluntarily contracted vigorously and frequently, until the periodic loss and recovery of force has become well marked, and then the voluntary contractions be replaced for a minute or two by contractions called out by electrical stimulation of the nerve, the periods immediately cease, although they return again as soon as voluntary contractions are resumed. Finally, it is worthy of note, that, in such an experiment, the periods are somewhat less frequent when the voluntary contractions are first resumed than they were just before the electricity was applied. In other words, that, while the nerve and muscle were working in response to the electric stimuli, the mechanism which was the seat of the changes causing the periodic variations of force had time to partially recover from its fatigue.

It seems almost certain, therefore, that the periodic loss

and recovery of power to make vigorous voluntary muscular contractions, which was seen in the experiments that have been described, was due to changes which occurred not in the peripheral mechanisms, but in the central nervous system. The periods do not, however, seem to be due to variations in the strength of the will power, because at a moment when it is impossible to make a strong voluntary contraction of one muscle, other muscles can be contracted with the usual vigor. The alterations which cause the periodicity must therefore be considered as located in some of the central nervous mechanisms, which lie between the areas of the brain which originate the will impulse, and the centrifugal nerves.

The experiments threw but little light on the nature of these changes. As has been said they are the result of fatigue, and they do not cease to occur as soon as the voluntary contractions cease, but their influence may be recognized for some minutes, at least, after the work has been stopped. The fact that the extensor of the thumb worked well when the flexors of the finger refused to obey the will, and vice versa, shows that the changes occurred independently in the mechanisms controlling each of these muscles. Though the periods were often almost rhythmical, they displayed so many variations that one cannot attribute them solely to a functional rhythm peculiar to these mechanisms. Indeed, it is probable that they were the result of a number of conflicting influences.

In addition to the marked periodic variations which have been discussed, there were observed even at the beginning of the experiment, when none of the mechanisms were fatigued, slight variations in the strength of the contractions. These were irregularly distributed, and were probably due, in part, to the inability of the subject to give his whole attention to the work and to always make the strongest possible voluntary effort. On the other hand, it may be remarked that most processes which depend on the activity of the central nervous system are subject to similar variations, and that such irregularities may well be considered as characteristic of the action of the higher nervous mechanisms.

The results here given were obtained from experiments which were made on the writer at twenty-five different times. In the few experiments which were made upon others, the periodicity was found well developed in the case of two strong and healthy young men, but failed to appear with definiteness in the case of six others. There can be but little doubt that the phenomenon is normal. Its absence in six out of the nine men examined, may be explained, in part, by the difficulties of the experiment, but was probably chiefly the result of the functionally different nervous systems of the men examined.

Other Similar Phenomena.

That fatigue should cause the strength of voluntary muscular contractions to vary periodically is less surprising when one recalls that fatigue causes a periodicity of many processes which depend on the action of the central nervous system. If one listens to the ticking of a distant watch, the sound is heard with periodically varying distinctness. If one looks long at a white sky, darkness sweeps from time to time over the field of vision. The intensity of "after-images" is subject to rhythmical variation. If one seeks to count the waves in a curve which record the vibrations of a tuning fork, he finds that, as he wearies, his ability to continue the counting varies more or less periodically. Much the same thing is true of such mental processes as adding a long column of figures, or the following of a long continued exact line of thought. There are intervals when the mind refuses to work, and these are soon followed by periods of almost unusual clearness.

Undoubtedly these phenomena would impress us more if we did not unconsciously yield to fatigue, and did not frequently rest ourselves. Even slight intervals of rest are sufficient to prevent the amount of fatigue which is necessary to reveal the phenomenon in marked degree.

In experiments made by the writer in Leipzig,[1] 1884, he found that if a constant temperature, high enough to cause

[1] Die räumliche und zeitliche Aufeinanderfolge reflectorisch contrahirter Muskeln. Du Bois-Reymond's Archiv. 1885.

reflex movements, but not so high as to rapidly destroy the tissues, were continually applied to the skin of the leg of a decapitated frog, the resulting reflex action was not a continuous tetanus, but a series of tetani, which followed one another with considerable regularity. In the intervals between the tetani, the muscles entirely relaxed, and the succeeding tetani were of nearly the same height. This phenomenon seemed to be dependent upon almost rhythmical changes occurring within the spinal cord, and closely resembles the results obtained in the experiments described in this paper.

Still another process, which naturally suggests itself as perhaps of similar nature to that under discussion, is the "Chene-Stokes respiration."

It is not impossible that the gaining of the so-called "second wind," so well known to runners, may depend, in part, at least, upon conditions similar to those which caused the first recovery noticed in my experiments; further the variation in the amount of difficulty experienced in maintaining long continued violent muscular action, is probably caused by functional changes, the same as those which produced the succeeding periods which have been described.

We have as yet but few and for the most part unsatisfactory tests of the functional activity of the central nervous system. Every new method which enables us to approach this difficult question is, therefore, of great importance.

MINOR CONTRIBUTIONS.

Studies from the Laboratory of Experimental Psychology of the University of Wisconsin.

By Joseph Jastrow, Ph. D.

By way of introduction to the first appearance in print of this Laboratory a few words may not be out of place. The Laboratory was founded in connection with the chair of Experimental and Comparative Psychology, established in the fall of 1888, the duties of which, I at that time assumed. The object of the Laboratory is primarily to give opportunity of demonstrating the chief points in a course in psychology, and of allowing students to test for themselves the simpler results of the methods of observation and experiment, and secondly to provide facilities for advanced and original work. In the programme of an American college the former end must stand out more prominently than it would, for example, in a German university. The original work in turn must be more directly under the guidance and control of the director of the Laboratory and the themes suited to the capacities and available time of the student. These, as well as the necessarily slow growth of a somewhat novel department, form the chief,— but I hope and believe constantly decreasing difficulties in the way of giving the actual a reasonable approximation to the ideal. My policy, however, is not to bring the researches conducted in the Laboratory under any one general scheme, but allow them to be suggested by the interest of the student, by the facilities of the Laboratory, or by the fluctuations of interest in the psychological world.

Regarding the present contributions, I have only to say that they will give evidence of some of the limitations under which they were worked out, but that I thought it wise not to delay their publication in anticipation of future results, but to send them forth as they are, to excite whatever interest and encourage whatever research they may. They are directed mostly to points connected with the problems of the psychophysic law, and may, perhaps, contribute a little toward bringing a much desired unity of conception into that vexed field.

Under the appropriate heading are mentioned the names of

the students who obtained the experimental results either directly with me or upon one another under my guidance. I trust to be able to continue these contributions at about yearly intervals.

On the Psychophysic Series.

The conformity of the magnitudes of the stars to the series demonstrated by the psychophysic law still remains one of the most striking applications of this law as well as an important piece of evidence in its favor. The stars were arranged in magnitudes on the basis of their naked-eye appearances, and at a time when any objective determination of their brightness was impossible. It is natural to suppose that the astronomers had in mind a sort of series in which the average stars of each magnitude should be separated by equal differences of brightness; i. e., by equal differences of sensation. When, now, we come to compare this psychic series with the physical series formed by the photometric determinations of the average stars of the several magnitudes, we find that this latter is approximately a geometric series with an average ratio of 2.5, for the first five or six magnitudes. To the arithmetical series of sensations separated by equal sensory differences there corresponds a geometric series of stimuli separated by a constant ratio; and this is the relation most closely answering to Fechner's formulation of his law. It is the most direct method of testing whether the sensations increase in arithmetic ratio as the stimuli increase in geometric ratio; i. e., whether the sensation increases with the logarithm of the stimulus. In this Journal, Vol. I, pp. 112–127, I have traced in detail the agreement of the estimations of star magnitudes with the phychophysic law, and in the present study my aim is to test whether this method can be applied to other fields of sensation, (for this, to my knowledge, has not yet been done), and with what results.

A.—Visual Extension.

My first attempt was with spacial relations of vision. A very large number of thin sticks varying arbitrarily in length from a few millimetres up to about 300 millimetres were mixed together in a random order; and the problem of the subject was to arrange these sticks according to length in a given number of classes or, to keep the comparison, of magnitudes. For this purpose I had made a frame with nine square openings, each one foot square, and with a bag hung within each compartment.[1] The whole was conveniently supported so that a person could sit with the sticks next to him

[1] The apparatus was constructed from a grant made me by the Elizabeth Thompson Science Fund, which I again gratefully acknowledge.

and sort them out according to a general impression of size. But one stick at a time was seen, and as soon as it was thrown into the bag it was lost from the subject's view. At first one's idea of the average length of each magnitude is vague, being founded only on the lengths of the extreme sticks that had been shown at the beginning of the experiment; but as one goes on his idea soon becomes clear, though puzzling cases of sticks just on the boundary between two magnitudes will always occur. When several hundred sticks had been thus assorted they were taken out and measured and the average length of the sticks in each bag computed. If the psychophysic law holds true of sensations of visual extension when thus tested, then these averages should form a geometric series with a constant ratio, just as do the photometric determinations of the average star-magnitudes. My results include the records of five persons sorting the sticks into six divisions, and of five sorting them into nine. Regarding the former, one observer declared himself dissatisfied with the result owing to the changing of the standards during the operation so that too many sticks had been thrown into the "longest" compartment. On examination this was found true and I have therefore omitted his result; the omission, however, does not effect the average result. The other four results are:

I.	Number of sticks,	79	133	89	70	56	88
	Average length,	18.5	55.6	97.7	146.8	194.7	251.1
II.	Number of sticks,	122	137	113	57	61	25
	Average length,	25.1	61.8	124.6	195.6	239.0	278.9
III.	Number of sticks,	236	65	59	59	60	37
	Average length,	45.9	106.1	147.5	184.2	231.3	273.8
IV.	Number of sticks,	200	79	103	52	51	50
	Average length,	36.8	90.1	142.3	200.7	239.9	275.2
Ar.	Number of sticks,	159	104	91	60	57	50
	Average length,	31.6	78.4	128.0	181.8	226.2	269.8

The last lines of figures represent the averages of I, II, III and IV. The following is a similar result for the sorting into nine magnitudes by five other observers, and their average:

I.	Number,	116	87	70	43	51	42	29	40	27
	Av. length,	62.8	84.5	111.7	139.5	164.5	187.8	215.5	233.5	252.2
II.	Number,	57	63	35	47	53	57	81	51	63
	Av. length,	44.5	66.6	73.5	92.0	107.4	136.2	164.9	212.8	231.8
III.	Number,	36	85	83	86	71	44	37	41	21
	Av. length,	40.3	65.4	86.6	121.6	156.6	190.3	218.2	235.0	254.8
IV.	Number,	15	27	39	67	86	116	78	69	11
	Av. length,	33.6	41.9	57.6	71.4	95.1	139.0	186.3	235.4	256.3
V.	Number,	56	80	82	63	66	58	56	27	18
	Av. length,	43.2	67.7	91.5	119.1	151.0	177.3	221.0	240.4	256.3
Ar.	Number,	56	68	62	61	65	63	56	46	28
	Av. length,	44.9	65.2	84.2	108.7	134.9	166.1	201.2	231.4	250.3

We need only compare the successive differences of the several magnitudes with their successive ratios to obtain an answer to our problem. Doing this for the average result we have:

Average difference,	46.8	49.6	53.8	44.4	43.6		
Average ratio,	2.48	1.63	1.42	1.24	1.19		
Average difference,	20.3	19.0	23.5	26.2	31.2	35.1	29.2	18.9
Average ratio,	1.45	1.29	1.27	1.24	1.23	1.21	1.15	1.08

In the division into six magnitudes it is quite clear that we have to deal with an *arithmetical* and not a geometrical series, or that the result is quite different from the result with star-magnitudes. In the division into nine magnitudes the difference between the two series is naturally considerably less, and so a decisive result the more improbable. The averages are considerably more irregular,[1] and the process is in every way more difficult. But if we regard the individual records as well as their average, we find that the balance of evidence tends towards making this also a coarsely approximate arithmetical series. If the series tends to a geometric one, it would be indicated by a tendency of the differences to rise with the magnitudes. Judged by this, test Numbers I, III and V, in the last table, are more or less arithmetical in their tendencies; Number II is very irregular, but can hardly be said to favor the geometric series; while Number IV does distinctly lean to the geometric. By a fortunate chance, Number IV is the only subject who appears in both experiments being the Number I of the "six division" series; and if we refer to that record, we find a very similar tendency there, though in the average it is entirely overbalanced by the "arithmetical" tendencies of the other three observers. We have thus indicated that whether or not the psychophysic law is obeyed in these experiments may be an individual matter. As a further test of this relation, I asked all of those who sorted the sticks into six magnitudes (as well as some of the others), after they had finished, to draw six lines of the lengths, equal to the average sizes of the magnitudes

[1] I shall not discuss the nature of these irregularities further than to emphasize the importance of the *number* of sticks in each magnitude upon the average length; the numbers are irregularly distributed, and it is very noticeable that so frequently when the number of sticks is very much larger, or very much smaller, than the average number, the average *length* of these sticks also deviates from the usual average. Again, the first and the last magnitudes are apt to be irregular, because all very small sticks go into the one, and all very large ones into the other, and the number of such sticks present will evidently affect these averages. When a large number of sticks is placed in the smallest magnitude, its average will be high, and the reverse is true for the highest magnitude. A similar effect is noticeable in star-magnitudes, for which see my paper as above cited.

which they had in mind when sorting the sticks. These estimations agree as well as could be expected with the results of measurements, both in the average (which I here append)

Lengths of lines:	47.5	82.5	120.0	156.7	193.5	244.7

and in the individual records, the subject with the distinct "geometric" tendencies also revealing this trait in the lines he drew. This would indicate a rather more definite and conscious representation of the several standard magnitudes than I for one should have anticipated.

To express the degree of approach of the average results in the two sets of experiments to an arithmetical series, I append these averages, together with the ideal series, to which they most closely approximate:

Real Series,	31.6	78.4	128.0	181.8	226.2	269.8
Ideal Series,	32.1	80.3	128.5	176.7	224.9	273.1

Real Series,	44.9	65.2	84.2	108.7	134.9	166.1	201.2	231.4	250.3
Ideal Series,	35.4	62.3	89.2	116.1	143.0	169.9	196.8	223.7	250.6

We can further express the average deviation of the actual from the ideal series as a percentage of the average lengths, and will find this to be 1.6% for the first set, and 3.8% for the second. These figures may be regarded as measuring the approximation of the result to an arithmetical series.

B.—Tactual-Motor Extension.

With the assistance of LUCIEN MASON HANKS and JAMES BREMER KERR.

The above mentioned experiments were made at the Psychophysical Laboratory of Johns Hopkins University, in the spring of 1888. In order to extend the application of the method, and to investigate whether the result would be the same with a less accurate sense, I decided to continue the study at my present laboratory by performing the same operation of sorting the sticks into six magnitudes, but with the difference that the sticks were not *seen* by the subject. The latter simply *felt* their lengths by moving his forefinger along them and announcing the compartments in which he wished them placed. Each was then thrown into the bag by an assistant, who also gave the subject the next stick he was to feel. The process is thus the same, except that this form of tactual-motor sensation takes the place of visual sensation. The test was made with four subjects. The range of sticks in length was a little narrower than with visual judgments (the longest stick being about 25 mm. shorter than the longest stick with visual judgments), and the number of sticks also smaller—about 360 against 500. The number of sticks and

their average length for each observer, and their average is as follows :—

I.	Number,	60	69	79	50	50	53
	Average length,	35.2	71.3	112.8	158.2	189.9	235.1
II.	Number,	67	81	69	68	48	27
	Average length,	57.0	76.1	118.6	170.6	206.4	244.3
III.	Number,	55	64	69	66	50	54
	Average length,	35.1	67.5	100.6	148.6	190.6	238.6
IV.	Number,	60	35	56	57	52	97
	Average length,	37.1	63.2	85.9	117.3	162.6	224.0
Av.	Number,	60	62	68	60	50	58
	Average length,	36.1	69.5	104.5	148.7	187.4	235.5

The ideal series, to which the average of the four results approximates, is 40.55, 70.45, 110.35, 150.25, 190.15, 230.05, the average deviation of the two series expressed as a percentage of the average length being 2.6%. With regard to the individual records nothing requires special mention, except the fact that Number IV shows a tendency to follow the geometric series, especially so if we take into account the error in the average length of the lowest magnitude due to its being the lowest. In brief, the result is in every respect essentially similar to that with visual magnitudes, and all that has been said of the latter applies with equal force to the former.

The nature of the result being thus clear, I will at the present time offer nothing more than a few thoughts in explanation of the holding good of the law with star-magnitudes and its failure with extension magnitudes. The two queries that these results suggest are: With regard to what class of sensations can the psychophysic law be expected to hold good? And may the agreement with the law depend upon the method by which it is tested? Respecting the former it seems to me that the law includes such sensations as are appreciated *en masse*, and with not too distinct a consciousness of their intensity; when the sensation is a sort of impressionist reception of the gross sensation without dividing it up into units, or conceiving it as so composed, we may expect the law to hold good. This would be the case with the rough estimations of star brightnesses. On the other hand, when the impression is consciously received and definite in extent, as with spacial relations, the correspondence of the arithmetical with a geometrical series can not be expected, for if I am asked to draw a series of equally different lines, or if I am asked to sort sticks into groups, I have in mind the division of the range into *equal* groups, and I cannot help asking myself whether these groups are to be equally different *absolutely* or

relatively. The former seems to be the simpler and more natural conception, and it is accordingly adopted, whenever the problem becomes a conscious one; that this is what the subject has in mind, is clear from the lines he draws as the equivalents of his average magnitudes. Again, the individual who follows the geometric series would be one who did not consciously state the problem to himself, but went on a general impressionist view of the matter. At present this is offered merely as a suggestion that brings harmony into the results and emphasises the important part played by consciousness in the estimation of sensations. With regard to the second question I desire only to bring it into relation with the first, by calling attention to the fact that the psychophysic law seems to hold good of this class of extensive sensations when tested by other methods, and that therefore possibly a difference in the mental attitude of the subject may decide whether the sensation will be perceived under the psychophysic law or not. Apart from the interest in the experiments as an extension of a psychophysic method to new fields, these are the points of view from which I trust the present research may be of interest.

The Perception of Space by Disparate Senses.

With the assistance of Frederick Whitton.

In a paper under this title, published in *Mind*, XI., No. 44, I offered the following as a provisional, but perhaps convenient, classification of the avenues by which we could gain knowledge of spacial relations:—

"I. By the stimulation of a definite portion of a sensitive surface:

(1) Of the retina (where the distance of the stimulating object must be inferred.)

(2) Of the skin.

(a) By the application of a pair of points, leaving the intermediate skin unstimulated, or

(a^1) Stimulating it by the application of a straight edge.

(b) By the motion of a point along the skin (see *Mind*, 40, pp. 557.)

[(a) and (b) may be contrasted as simultaneous and successive.]

"II. By the perception of distance between two movable parts of the body, *e. g.*, between thumb and forefinger.

"III. By the free motion of a limb, *e. g.*, the arm."

I then proceeded to investigate in detail the space relations furnished by a variety of I (1), of II and of III, deducing a

series of relations in part to be referred to in the present study, but for a full account of which the reader must have recourse to the original memoir. In the present study a form of I (2) (*a*) was interpreted by drawing lines with the aid of the eye, in which process the eye is naturally the guiding sense.

The method of work was as follows: Two spots were marked upon the volar surface of the forearm of each arm, one near the elbow, the other near the wrist. One of a pair of points was applied either to the lower (near the wrist), or the upper (near the elbow) of these points, and the other at various arbitrarily selected distances from the former. It goes without saying that the subject was prevented from seeing the pair of points applied to the arm by the interposition of a screen. Ten observations were made in a set, keeping one of the points constant throughout. The subject appreciated the distance between the points, and drew with a pencil a line, the length of which seemed to his tactual sensation, (not to his judgment or actual knowledge of the relation,) equal to it.

Even this was a difficult task, owing to the coarse sensibility of the forearm, and the estimations were made with little confidence and much hesitation and fluctuation. Owing to this, it was allowed to have the points applied (for a moment only) as often as the subject required, and he could correct and recorrect the lines drawn, until he felt satisfied with the result. Again, the arm fatigues very easily, especially at and near the point under constant stimulation, this being mainly due to the rather strong impression of the points necessary to give a distinct sensation. The apparatus employed was the æsthesiometer I described and figured in the proceedings of the American Association for the Advancement of Science, 1887, and also partly in this JOURNAL, Vol. I, p. 552.[1] I again take the opportunity of gratefully acknowledging the grant made me by the "Elizabeth Thompson Science Fund," by aid of which this apparatus was constructed.

The smallest lengths applied were determined by the smallest distance between the two points still felt as two; the largest by the dimensions of the forearm. Four cases were distinguished, according as (1) the right or (2) the left arm was

[1] The only change made was in setting the bar bearing the points upon adjustable brackets projecting at right angles from the uprights, to enable the arm to rest more conveniently beneath it. I will not describe the apparatus further than to remark that it offered great facility in leaving the operator both hands free for work, in applying both points equally well and always in the same way, and in making the setting and recording of distances extremely easy. The only difficulty is in the disposition of the arm to give both ease of application and comfort.

used, and as (*a*) the upper or (*b*) the lower point was kept constant, the latter distinction is necessary, because the sensibility differs at the two points. This was tested as a rule both before and after each set of ten observations; it being found that the fatigue incident to the experiments diminished the sensibility. The results of these observations are embodied in the following table:

J. JASTROW.	RIGHT ARM.		LEFT ARM.	
	UPPER CONSTANT.	LOWER CONSTANT.	UPPER CONSTANT.	LOWER CONSTANT.
Before	58.0	31.7	57.4	33.0
After	68.8	46.0	73.2	42.5
Average	63.4	38.9	65.3	37.8
F. WHITTON.	RIGHT ARM.		LEFT ARM.	
	UPPER CONSTANT.	LOWER CONSTANT.	UPPER CONSTANT.	LOWER CONSTANT.
Before	52.3	32.2	64.8	37.2
After	64.0	41.7	77.0	51.0
Average	58.2	37.0	70.9	44.1

The numbers express in millimetres the distances between two points just felt as two. It would be fairest to consider the average sensibility throughout the experiments as the mean of the sensibility before and after, and this is accordingly added in the table. The table shows: (1) That the sensibility at the lower point (near the wrist) is finer on both arms and for both observers than at the upper point (near the elbow), and on the average the points are perceived as distinct when 25 mm. nearer. (2) That the average just perceptible distance is for the upper point 64.5 mm., for the lower 39.5 mm. (3) That for Mr. Whitton the right arm is more sensitive both above and below than the left, while no such difference is apparent for myself. (4) That the effect of the fatigue increases the just perceptible difference after ten observations on the average by 12.2 mm.

As regards the chief object of the investigation, I have in the following table divided the observations into five groups, aiming to have the averages of the groups separated by about equal intervals, and have placed under each average distance between the points, as applied upon the forearm, the average length of the lines by which it was represented, and under this in turn the ratio of the two expressed as a percentage. This is done separately for Mr. Whitton and myself, and with the distinction of the four cases as already noted.

J. JASTROW.

	RIGHT ARM: UPPER POINT CONSTANT.					RIGHT ARM: LOWER POINT CONSTANT.				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
Real length . . .	64.0	80.0	101.2	120.0	139.5	59.4	79.0	101.7	121.9	145.0
Drawn length . .	15.0	19.7	25.2	38.1	56.4	17.6	23.0	32.7	42.9	53.8
Ratio in percentage	23.4	24.6	24.8	31.7	40.4	29.6	28.1	32.1	35.2	37.1

	LEFT ARM: UPPER POINT CONSTANT.					LEFT ARM: LOWER POINT CONSTANT.				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
Real length . . .	63.0	80.4	102.3	123.0	138.0	60.4	81.3	100.8	121.5	141.0
Drawn length . .	12.7	17.8	29.8	43.7	56.1	14.9	23.0	32.1	41.9	61.4
Ratio in percentage	20.2	22.1	29.1	35.5	40.6	24.7	28.3	31.8	34.5	43.6

F. WHITTON.

	RIGHT ARM: UPPER POINT CONSTANT.					RIGHT ARM: LOWER POINT CONSTANT.				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
Real length	64.2	82.7	101.2	120.8	138.3	55.6	79.2	99.8	120 0	137.5
Drawn length . . .	42.8	51.1	70.6	79.2	87.7	39.3	58.2	74.8	82.1	98.8
Ratio in percentage	66.7	61.8	69 8	65.6	63.5	70.7	73.5	75.0	68.4	71.9

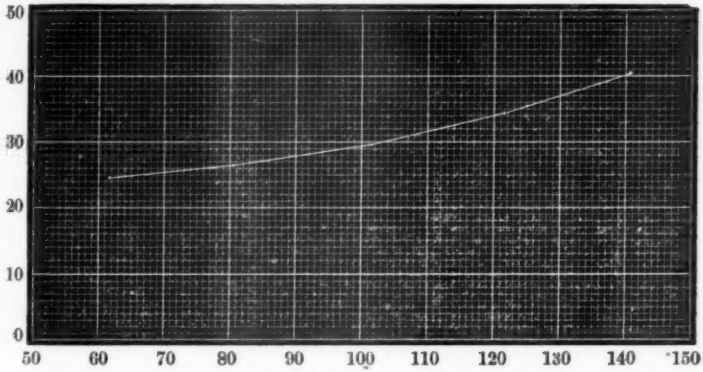
	LEFT ARM: UPPER POINT CONSTANT.					LEFT ARM: LOWER POINT CONSTANT.				
	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
Real length. . . .	65.0	82.0	102.5	121 7	141.2	57.7	80.3	100.7	117.5	129.6
Drawn length. . .	30.0	42.5	60.5	75 8	97.0	39.7	59.9	70.0	88.5	97.6
Ratio in percentage	42 2	52.0	59.0	62.3	67.2	68.8	74.6	69.6	75.3	75.3

These Tables show: (1) *That the lengths are all very much underestimated*, the lines being on the average 65.6% of the distances between the points for Mr. Whitton and but 30.9% for myself; (2) That for myself throughout *the underestimation decreases as the length increases*, though for Mr. Whitton this is true in one of the four cases only; (3) That the underestimations are less when the lower point than when the upper point is constant, on the average by 7.2 mm. for Mr. Whitton, by 3.9 mm. for myself; (4) That for myself there is no difference between the sensibility of the two arms, but for Mr. Whitton the right arm is slightly more sensitive than the left.

Postponing the further discussion of these results, I will assume that the average sensibility along the arm is that midway between the sensibility at the upper and at the lower point, and that there is no difference in sensibility between the two arms; I then take my own result as rather the more regular of the two and obtain the most typical result by combining the four cases for myself as is done in the following table:

Real length,	61.7	80.2	101.5	121.6	140.9
Drawn length,	15.1	20.9	29.9	41.7	56.9
Ratio in per cent.,	24.4	26.1	29.5	34.2	40.4

The same is expressed graphically in the accompanying curve.[1]



I shall now discuss the relation of this result to the conclusions of my former paper. Such discussion can only include the most general relations, a minute comparison being impossible owing to the difference in the number of subjects and observations. The most general conclusion of my former paper here pertinent is that "*If the eye is the expressing sense all lengths are greatly underestimated*, the error decreasing as the length increases.[2] With this general result this curve is entirely in agreement, although the decrease of the error with the increase of the length is not as marked, owing in part to the smaller range of lengths that the observations cover. Regarding the comparative accuracy of the feeling of tension between thumb and forefinger, the motor sensations of the arm and the skin sensibility of the fore-arm, accurate statement is impossible, but the indication is that the last is a less accurate source of space-perception than either of the others. My general result is thus an additional verification of the conclusions reached in my former study, and an extention of their significance. The space-perceptions of disparate senses are themselves disparate, and whatever harmony there is among them we are warranted in regarding as the result of experience. The

[1] The ordinates express the drawn lengths as percentages of the real lengths, the latter being indicated by the abscissæ.

[2] Though the method of expressing by the eye is different here from what it was in the former study (no pains being taken to restrict the movement of the eye and the hand moving over the space drawn). I do not think it likely that this difference at all seriously influenced the results owing to the supremacy of the eye in all spacial judgments.

spacial notions of one deprived of the sense of sight and reduced to the use of the other space-senses must indeed be different from our own. And the existence of the striking disparities between our visual and our other space-perceptions, without confusing us, and, indeed, without usually being noticed, can only be explained by the tendency to interpret all dimensions into their visual equivalents and unconsciously correct them by the same means. The general law to which the result contributes seems to establish a sort of co-efficient of conversion; the same amount of objective stimulation upon a delicately sensitive surface is interpreted subjectively as the equivalent of a much more extensive sensation than an equal objective stimulation upon a coarsely sensitive sense-organ. There is, as it were, an exchange of the spacial units of different senses, and because the visual units are the smallest it takes a smaller visual space to seem equal to a larger tactual or motor space.

A few points peculiar to the present research remain to be noted. The first is the peculiar fact that when the points are extended a few millimetres there is a sort of jump from the point at which no interval at all is felt (the two points being felt as one) to the perception of the entire interval. The moment we perceive an interval at all, we regard it as longer than the mere separation of two points; it is not that the zero point is at a constant height, but that the sensation changes its character. To my knowledge the theory of dermal sensibility is too little advanced to give an adequate explanation of the fact, nor have I any to offer. The fact itself seems to me important, and must be accounted for by any theory that claims general acceptance. A second point is that while the sensibility at the upper and at the lower points differs by about 25 mm. the difference in their reproductions is only about 5.5 mm. Even if we regard this difference as subject to the same underestimations as the absolute lengths it is strikingly small; but the explanation of the fact is even more difficult than of the foregoing.

On the Pressure Sense.

With the assistance of Sarah Belle Flesh and Helen Smith.

The problem set proved a much broader one than could be profitably worked out in the limited time at the disposal of the experimenters, so that only two aspects of the work can be here described, both of these relative to the methods of testing sensibility. The apparatus used for testing the pressure-sense was a modification of a Fairbanks' post-office balance, in which the initial and incremental weights were

placed upon the scale-pan, thus exerting an upward pressure upon the finger situated at the end of the beam. A series of attachments were added by which the pressure could be instantly released from the finger and thus the ill effects of fatigue averted. A comfortable and firm position of the arm, hand and finger was also secured. To obtain a normal sensibility, experiments were made according to the method of right and wrong cases, the subject being requested to answer each time, and doubtful answers being excluded so that half the answers would be correct by chance. At the bidding of the subject a pressure was brought to bear upon the finger; at a second signal the pressure was increased or diminished, and at a third the original weight was restored. The subject had to decide whether the middle pressure was lighter or heavier than the extremes. The two initial weights applied were (A) 315 and (B) 105 grms., and the changes were an increase or decrease by (1) $\frac{1}{7}$ or (2) $\frac{1}{21}$ of these weights. An attempt was also made to record the confidence[1] in the correctness of one's answer on a scale in which 3 signified relative certainty, 0 no preference for one answer above its opposite, and 1 and 2 intermediate grades of feeling. After throwing out certain observations made under distracting circumstances there remain 100 observations for each observer under each of the four cases. These are given in the table, together with the theoretical ratio at which according to the formula given in my paper published in this JOURNAL (Vol. I, p. 308), one-fourth of the answers should be correct.

MISS SMITH.

Initial weight.	Ratio of increment.	Percentage of error.	Ratio at which 25 per cent. errors would occur.	Average confidence
315 grammes	$\frac{1}{7}$ = 1.143	4.0	1.053	1.22
315 "	$\frac{1}{21}$ = 1.048	19.0	1.037	0.60
105 "	$\frac{1}{7}$ = 1.143	3.0	1.049	1.17
105 "	$\frac{1}{21}$ = 1.048	20.0	1.038	0.60

MISS FLESH.

Initial weight.	Ratio of increment.	Percentage of error.	Ratio at which 25 per cent. errors would occur.	Average confidence
315 grammes	$\frac{1}{7}$ = 1.143	10.0	1.073	0.78
315 "	$\frac{1}{21}$ = 1.048	34.0	1.080	0.54
105 "	$\frac{1}{7}$ = 1.143	12.0	1.077	1.14
105 "	$\frac{1}{21}$ = 1.048	40.0	1.132	0.62

The constancy of these numbers measures the constancy of

[1] This method was used in the research by Mr. Peirce and myself on "Small Differences of Sensation," Memoirs of the National Academy, Vol. III, and also in the paper in *Mind*, No. 44.

the sensibility as well as the agreement of the results with the requirements of the psychophysic law. The law seems approximately adhered to, though with variations depending largely on the small number of observations. The average ratio at which 25 per cent. of errors should occur is for Miss Smith 1.044, for Miss Flesh 1.090, the mean of which is 1.067; and as this measures the most probable error we in a certain sense express the fineness of the pressure sense as here determined, by saying that its probable error is 1.067 or about $\frac{1}{15}$.

A second series of observations was made under the same conditions except that instead of applying and removing the additional weight while the initial weight is upon the finger, the initial weight is applied and removed; then the initial plus or minus the additional weight is applied and removed; and then the initial alone again. The question is whether we can compare more accurately the change of a sensation x with the sensation $x \pm a$ (produced by simply adding or subtracting a), or the entire sensation x with the entire sensation $x \pm a$. The result for Miss Flesh is too much affected by what must be accidental errors to be here cited, but for Miss Smith it is as follows; the result is arranged as in the preceeding:

Initial weight.	Ratio of increment.	Percentage of error.	Ratio at which 25 per cent. errors occur.	Average confidence.
315 grammes	$\frac{1}{7} = 1.143$	11.2	1.077	0.27
315 "	$\frac{1}{21} = 1.048$	30.0	1.062	0.11
105 "	$\frac{1}{7} = 1.143$	12.5	1.081	0.27
105 "	$\frac{1}{21} = 1.048$	31.6	1.068	0.00

We see that this second method is decidedly the more difficult, the average "probable error" rising, for Miss Smith, from .044 to .072. The psychophysic law is well supported, though here as before the subject appreciates differences of $\frac{1}{15}$ relatively better than differences of $\frac{1}{7}$. Regarding the causes of the increased difficulty of the second method of experimentation it may be in point to note that memory has a wider play in it than in the former method, though this is not the entire psychological difference. The result shows too, how essentially tests of sensibility are dependent upon the methods employed.

Regarding the confidence we see that it rises as the proportion of error decreases and falls as this proportion increases; what this relation is I have no means of determining, nor do I think that it is constant or anything more than a subjective but practically useful aid in judging the reliability of the results.

On Just Observable Differences.

With the assistance of Augusta Adrienne Lee.

The usual applications of the method of the Just Observable Difference aim to fix by more or less direct means the point at which two sensations are sufficiently different to have that difference consciously perceived when the attention is directed to it, and to arouse some confidence in the correctness of one's judgment of this difference. I have elsewhere[1] pointed out the uses and the abuses of this method and will here confine myself to the description of a hitherto unnoticed mode of testing the Just Observable Difference. A distinction, the importance of which is not always recognized, is that between the power to tell that two stimuli are different and the power to tell the direction of this difference. In some cases the later is always given with the former, but in others it is not. A great many persons can tell that tones are different without being able to tell which is higher and which lower. It matters much, too, whether the two stimuli are successive or simultaneous; and in the estimation of spacial relations it is important whether the two stimuli are placed side by side, so that their relations are manifest, or not. The form of the method now to be described is certainly a useful variation of it, and yet as far as I know has not been employed. It consists *in having the subject produce a stimulus just longer (more intense) or just shorter (less intense) than a given stimulus;* instead of judging differences presented to him he produces the smallest difference that he can. By this method a knowledge of the direction of the difference is made necessary.

In the first series of experiments fifty lines were drawn, their lengths varying in an arbitrary manner from about 25 to 150 mm.; and after viewing one line it was covered over, and the attempt made to draw a line just longer than the one seen. In the next series the attempt was made to draw the lines just shorter than the original lines; and in a third series (in order to eliminate a constant error, if there be any), the attempt was made to draw the lines just equal. In another set of experiments the same three processes were repeated, but the original line was kept in sight while the second was being drawn, though the two were kept at some distance apart so as not to make a fitting of the ends of the lines possible. The average number of millimetres by which a line differs from the original line under the three cases and when the original line was visible or not is given in the following table. I also give with this, the ratio of the average length of the

[1] See this Journal, Vol. I, pp. 273-277 and 299-302.

line to this just perceptible difference expressed as a percentage.

ORIGINAL LINE NOT SEEN.		
Just longer.	Just equal.	Just shorter.
2.17 mm. = 2.75 %	0.73 mm. = 0.92 % (Total error = 1.20 mm.)	2.50 mm. = 3.60 %
ORIGINAL LINE SEEN.		
2.56 mm. = 4.01 %	0.36 = 0.56 % (Total error = 2.04 mm.)	3.78 mm. = 4.97 %

The conclusions that I draw from these results are: (1) that the error when the two lines are seen is less than when not (the case when the lines are drawn equal is no exception if we count as we ought the absolute error positive and negative; these cancel one another in the latter case and so give an appearance of greater accuracy); (2) the just perceptible difference is greater in drawing the just shorter than the just longer lines; (3) the error in drawing lines equal is quite small, and its effect upon the other results not marked enough to appear in these few observations; (4) the just perceptible differences are considerably larger than those found with the more usual method. This last I would bring under the general law that our powers of execution fall short of our powers of discrimination. If the psychophysic law is true it would appear in this method in the fact that the just perceptible difference would bear a constant ratio to the length reproduced. If I divide the lines into short, medium and long lines, I get three just perceptible differences that are approximately constant ratios of the average lengths. I desire here mainly to call attention to this psychophysic method as a natural and easy method of obtaining a reliable quantitative result, and one easily comparable with the results of other methods.

CHILDREN'S LIES.

During the past few years a small number of accomplished and tact-full lady teachers, finding in even the best ethical literature little help in understanding and in dealing with certain current and more or less licensed forms of juvenile dishonesty connected with modern school-life, have undertaken, as a first step towards getting a fresh and independent view of the facts of the situation, to question and observe individual children, by a pre-determined system, as to their ideals and practises, and those of their mates in this regard. These returns now represent nearly three hundred city children of both sexes, mostly from twelve to fourteen years of age, selected, generally, by the teachers as average or representative children in this respect, and interviewed privately and in an indirect way, most carefully so designed as to avoid all indelicacy to the childish conscience. From the nature of the subject, and from the diverse degrees, not only of interest, but even of trustworthiness of the individual returns, as well from the fact that the experience and opinion of many teachers were also gathered, the results hardly admit tabular statistical presentation. A general statement of them, according to the groups into which they naturally fall, will be serviceable, it is hoped, to thoughtful parents and teachers as well as to psychologists.

I. No children were found destitute of high ideals of truthfulness. Perhaps the lowest moral development is represented by about a dozen children who regarded every deviation from the most painfully literal truth as alike heinous, with no perspective or degrees of difference between white and black fibbing and the most barefaced intended or unintended lies. This mental state, though in a few cases probably priggish and affected, became in others so neurotic that to every statement, even to yes and no, "I think" or "perhaps," was added mentally, whispered, or in two cases aloud, and nothing could prompt a positive, unqualified assertion. This condition, not unknown among adults in certain morbid states of conscience, we will designate as *pseudophobia*, and place it among the many other morbid fears that prey upon unformed or unpoised minds. One boy told of "spells" of saying over hundreds of times when alone the word "not," in the vague hope it might somehow be inter-

polated into the divine record of his many wrong stories, past and future, to disinfect them and neutralize his guilt. Another had a long period of fear that like Ananias and Sapphira he might some moment drop down dead for a chance and perhaps unconscious lie. As in barbaric lands a score of crimes, though perhaps recognized as of different degrees of depravity, are worthy the maximal penalty of death, so inaccuracies of statement, though distinguished from blacker falsehoods, are still lies, though unintended. This moral superstition, which seemed mostly due to mixing ethical and religious teaching in unpedagogic ways or proportions in home or Sunday school, is happily rare, generally fugitive, is not germane to the nature of childhood, and is likely to rectify itself. Where it persists it begets a quibbling, word-splitting tenddency, a *logolatry*, or a casuistic habit resulting sometimes in very systematized palliatives, tricks and evasions, which may become distinctly morbid. There are few children even at the beginning of public school life who need much help in distinguishing between unintentional and premeditated wrong statements, and yet a little aid in so doing, if given with proper illustrations and tact, is almost sure to be serviceable in developing a healthful moral consciousness. Of this state we desire more records of cases with details illustrative of cause and cure, etc.

II. Strongly contrasted with this state, and far more common, is that in which lies are justified as means to noble ends. Children all admire burly boys who by false confessions take upon themselves the penalties for the sins of weaker playmates, or even girls who are conscious of being favorites with teacher or parent, or of superior powers of blandishment, and who claim to be the authors of the misdeeds of their more disfavored mates. The situations, especially the latter, were met with many times, and the act was always approved though often with some rather formal qualifications. One case, which bore traces of idealization, was described in which the quality of the heroism was of almost epic magnificence, and the sin-bearer's gracious lie seemed to have quite passed out of sight. A teacher who told her class of thirteen-year-old children the tale of the French girl in the days of the commune, who, when on her way to execution on a petty charge, met her betrothed and responded to his agonized appeals, "Sir, I do not know you," and passed on to death alone because she feared recognition might involve him in her doom, was saddened because she found it so hard to make her pupils name as a lie what was so eclipsed by heroism and love. Children have a wholesome instinct for viewing moral situations as wholes, but yet are not insensi-

tive to that eager and sometimes tragic interest which has always for all men invested those situations in both life and in literature where duties seem to conflict. The normal child feels the heroism of the unaccountable instinct of self-sacrifice far earlier and more keenly than it can appreciate the sublimity of truth. Theoretic or imagined cases of this kind were often volunteered by the children with many variations. They declare, *e. g.*, that they would say that their mother was out when she was in, if it would save her life, giving quite a scenic setting to such a possible occurrence, adding infrequently that this would not make it *exactly* right, though it would be their duty to do it, or that they would not tell a like lie to save their own lives. A doctor, too, many suggested, might tell an over-anxious patient or dearest friend that there was hope, easing his conscience, perhaps, by reflecting that they had some though he had none. In confronting such cases, it is the conscientious parent or teacher who is most liable to get nervous and err. It is feared, that although the end is very noble and the fib or quibble very petty at first, worse lies for meaner objects may follow. The fondness and even sense of exhilaration, with which children often describe such situations, is often due to a feeling of easement from a rather tedious sense of the obligation of undiscriminating, universal and rigorously literal veracity, under which also very often lurks an effort to find the flavor of exculpation for more inexcusable lies. The teacher may by multiplying, analyzing, or even by too much attention to such cases develop a kind of morbid ethical self-consciousness and precocity. He may, as the history of education shows, make even children into casuists gravely disputing about the grand moral forces that beneath all others make the world of man their revelation or their sport. No two children and no two moral situations are alike. Here human science faces problems still too complex for formulation, where the adult has really very little to teach the child, and where conference and suggestion, and even instruction, should be restricted to specific and individual cases and not lapse into generalization. The special pedagogic utilization of these cases should generally, we believe, be the following. The child who gets really interested in what it deems the conflict of veracity with other duties, may be reverently referred to the inner light of its own conscience. This seems to be a special opportunity of nature for teaching the need of keeping a private protestant tribunal where personal moral convictions preside, and which alone enables men to adapt themselves to new ethical situations or environments.

III. With most children, as with savages, truthfulness is

greatly affected by personal likes and dislikes. In many cases they could hardly be brought to see wrong in lies a parent or some kind friend had wished them to tell. Often suspected lies were long persisted in till they were asked if they would have said that to their mothers, when they at once weakened. No cases were more frequent than where, in answer to a friend's question, if some thing or act they did not particularly admire, was not very nice or pretty, they found it hard to say no, and compromised on "kind of nice," or "pretty enough," when if a strange pupil had asked they would have had no trouble with their consciences. The girls in our returns were more addicted to this class of lies than boys. Boys keep up joint or complotted lies which girls rarely do, who "tell on" others because they are "sure to be found out," or "some one else will tell," while boys can be more readily brought to confess small thefts, and are surer to own up if caught, than girls. A question of personal interest with girls is how far etiquette may stretch truth to avoid rudeness or hurting others' feelings. All children find it harder to cheat in their lessons with a teacher they like. Friendships are cemented by frank confidences and secrets and promises not to tell, as adults with real attachments desire to know and be known without reservation, without over-praise or flattery, and to rely on and perform pledges. To simulate or dissimulate to the priest, or above all, to God, was repeatedly referred to as worst of all. On the other hand, with waning attachment, promises not to tell weaken in their validity. Strange children, and especially impertinent meddlers, may be told "I do not know" when one means "none of your business" as a mental reservation. Children say they are not going to a place they intend to visit to avoid unwelcome company, and victimize an enemy by any lie or strategy they can invent. Truth for our friends and lies for our enemies is a practical, though not distinctly conscious rule widely current with children, as with uncivilized and, indeed, even with civilized races. Rural children are more liable to long and close intimacies, and are more shy and suspicious of all strangers. The sense of personal loyalty to those who are admired is so strong that it has produced, not only many kinds and systems of fagging, but inclines children to mistake what pleases their idol as good and true. If their favorites desire or even admit them to lie or cheat for their benefit, as false codes sometimes require, if extravagant vows or protestations are made that cannot be kept, or that must be kept at great moral cost, or if too many secrets are shared that need often to be guarded by prevarications, then children are being trained for corrupt combina-

tions of any sort in adult life. On the other hand it is through the instinct of personal fealty, so strong in children that most men have grown up to a sense of fidelity to God and even of the obligation of scientific truthfulness. It has taken mankind long enough to learn the sublimity of a kind of truthfulness which is no respecter of persons. The best correction of this general tendency of children, we believe to be instruction in science, the moral needs and uses of which alone call loudly for more of it and better. But the teachers of younger children should look well to their friendships, and study, especially, the character of leaders and favorites and try to mould it as well as strive to be loved by all, not forgeting that only children with bad friends are worse off than those with none, and that they will be more faithful to great causes for having been faithful to dear and good friends.

IV. The greatest number of lies in our collections are prompted by some of the more familiar manifestations of selfishness. Every game, especially, every exciting one, has its own temptation to cheat; and long records of miscounts in tallies, moving balls in croquet, crying out "no play" or "no fair" at critical moments to divert impending defeat, false claims made to umpires, and scores of others show how unscrupulous the all-constraining passion to excel often renders even young children. In those games which attract wider attention, where sets of picked players are pitted against one another, and its prizes in local fame are great and immediate, dexterity in cheating is sometimes regarded as a legitimate qualification along with others, the only discredit being, as in the lies Spartan children were encouraged to tell, in getting found out. Lies of this kind, prompted by excitement, are so easily forgotten when the excitement is over that they rarely rankle, and are hard to get at, but they make boys unscrupulous and grasping. School life is responsible for very many, if not most of the deliberate lies of this class. Where the vicious system of self-reporting for petty offenses, like whispering, exists, children confess not showing their hands when they are guilty. If pressed to tell if they saw or did a wrong they lie, and add, perhaps, that it is very easy to lie to get out of school scrapes. Few will not give, and not many will not take prompts or peep in their books, especially if in danger of being dropped or failing of promotion. Children copy school work and monitors get others to do theirs as pay for not reporting them, while if a boy is reported he tells of as much disorder as possible on the part of others, to show that the monitor did not do his duty. As school work is now done, much of it is of a kind that can be bought and sold. One teacher in a large city stated that so much

more than they could really do was now required of her pupils that she and her teacher friends were now obliged, in order that their rooms should not be unfavorably reported, to rewrite the English exercises of many of their pupils, to be copied again by them before being seen by the examiners who had no time to see the work in process of doing. This could hardly have been a lesson in honesty to the pupils. The long list of headaches, nosebleeds, stomach-aches, etc., feigned to get out of or avoid going to school, of false excuses for absence and tardiness, the teacher, especially if disliked, being so often exceptionally fair game for all the arts of deception; all this seems generally prevalent. This class of lies ease children over so many hard places in life and are convenient covers for weakness and even vice. To lie easily and skilfully removes the restraint of the more or less artificial consequences attached by home and school to childish wrong-doing, and increased immunity always tempts to sin. The facility with which a whole street or school may be corrupted in this respect, often without suspicion on the part of adults, by a single bold, bad, but popular child, the immunity from detection which school offers so much more than home for even habitual lies of this class, as well as the degree of moral degradation to which they may lead, all point to selfish falsehoods — especially when their prevalence is taken into account—as on the whole the most dangerous, corrupting, and hard to correct of any of our species. Excessive emulations, penalties, opportunities, and temptations should of course be reduced, but it should be clearly seen that all these lies are at bottom, in a peculiar sense, forms of self-indulgence, and should, in the great majority of cases, be treated as such, rather than dealt with directly as lies. The bad habits they cover should be patiently sought out and corrected, for those who habitually do ill are sure to learn to lie to conceal it. The sense of meanness this slowly breeds must be met by appeals to honor, self-respect, self-control. Hard and even hated tasks, and rugged moral and mental regimen should supplement those modern methods which make education a sort of self-indulgence of natural interests.

V. Much childish play owes its charm to partial self-deception. Children imagine or make believe they are animals, making their noises and imitating their activities; that they are soldiers, and imagine panoramas of warlike events; that they are hunters in extreme peril from wild beasts; Indians, artisans, and tradesmen of many kinds; doctors, preachers, angels, ogres. They play school, court, meeting, congress. If hit with wooden daggers in the game of war they stand aside and play they are dead. If they step on a crack in

walking the floor, curbing, sidewalk, etc., they call it they are poisoned. Protruding spots of earth or land in pools or ponds, or at half-tide in the bay, suggest the geography of a continent, and in one case, for years, Boston, Providence, West Indies, Gibraltar, Brooklyn Bridge were thus designated by all the children of a large school in their plays. In another, a dozen hills and valleys, rills, near by were named from fancied resemblance to the familiar mountains, rivers and valleys of the geography. The play-house sometimes is so real as to have spools for barrels of flour, pounded rotten wood for sugar, pumpkin chairs, cucumber cows, moss carpets, sticks for doors which must be kept shut, sometimes cleaned, twig brooms, pet animals for stock with pastures and yards, all the domestic industries in pantomime, toadstools, lichens and puff-balls for bric-a-brac, while some older boy and girl may play parents with secret pet names, and younger ones as children, often for a whole term and in rare instances for years; all of this of course being almost always in the country. They baptize cats, bury dolls, have puppet shows with so many pins admission, all with elaborate details. They dress up and mimic other often older people, ride on the horse cars and imagine them fine carriages, get up doll hospitals and play surgeon or Florence Nightingale. The more severe the discipline of the play-teacher and the more savage the play-mother the better the fun.

One phase of this is exquisitely illustrated in the life of Hartley Coleridge, by his brother. His many conceptions of his own ego—e. g., by the picture Hartley, shadow Hartley, echo Hartley, etc.; his fancy that a cataract of what he named jug-force would burst out in a certain field, and flow between populous banks where an ideal government, long wars and even a reformed spelling illustrated in a journal devoted to the affairs of this realm, were all developed in his imagination where they existed with great reality for years; his stories to his mother continued for weeks; his reproduction of all he had seen in London, its theater, laboratory, and what he had read of wars, geographical divisions, in a large play-ground appropriated to his use,—these all illustrate this normal tendency, but in a degree of intensity probably morbid, much resembling the pseudo-hallucinations of Kandinsky. Two sisters used to say, "let us play we are sisters," thus making the relation more real. Cagliostro found adolescent boys particularly apt for his training to subserve the exhibition of the phrenological impostures illustrating his thirty-five faculties. He lied when he confessed he had lied, said a young Sancho Panza who had believed the wild tales of another boy who later confessed their falsity. Sir James Mackintosh in youth after read

ing Roman History used to fancy himself the emperor of Constantinople, and carry on the administration of the realm, hours at a time and often resumed for months. These fancies of his never amounted to conviction, but doubtless excited a faint expectation, which, had they been realized, would have lessened wonder. Charlotte Elizabeth lived largely in an imaginary realm for years in her youth.

In some games like "crazy mother," younger children are commanded, or older ones stumped or dared, to do dangerous things, like walking a picket fence or a high roof, etc., in which the spirit of play overcomes great natural timidity, and by playing school with other mates, or perhaps parents, they are helped by the play instinct to do hard examples and other hated tasks they had scarcely accomplished in actual schools. The stimulus and charm of the imagination makes them act a part different from their natural selves; some games need darkness to help out the fancy. It seems almost the rule that imaginative children are more likely to be dull in school work, and that those who excel in it are more likely to have fewer or less vivid mental images of their own. Especially with girls, it is chiefly those under ten or twelve who play most actively in our school yards, but those of thirteen or fifteen, who, under the apathy that generally affects girls of that age, walk in pairs, or small groups up and down the yard and talk, are no less imaginative. One early manifestation of the shadowy falsity to fact of the idealizing temperament is often seen in children of three or four, who suddenly assert that they saw a pig with five ears, a dog as big as a horse, or, if older, apples on a cherry tree, and other Munchausen wonders, which really means at first but little more than that they have that thought or have made that mental combination independently of experience. They come to love to tell semi-plausible stories, and perhaps when the astonishment is over to confess. Or, again, all stories of men and things they hear are given a setting in the natural scenery, or far less often, in the houses they know best, and their friends are cast in the rôles. The fancy of some children is almost visualization, and a few will tell at once, e. g., what was the color of Barbara Frietchie's dress, whether she wore glasses and a cap, just where in their father's sheep-pasture the goblin in the Arabian Nights rose out of the bottle, if pictures of these objects have not obviated the normal action of this faculty. Revery which materializes all wishes, and the mythopœic faculty which still occasionally creates a genuine myth among children, boys who amuse their mates with long and often clever yarns of their own invention, girls who make up ridiculous things about others—to all these the school has paid little attention, and Mr. Grad-

grind would war upon them all as inimical to scientific veracity. We might almost say of children at least, somewhat as Froschamer argues of mental activity, and even of the universe itself, that all their life is imagination. Such exercise of their faculties children must have even in the most platonic school republic. Its control and not its elimination is what is to be sought in the high interest of truthfulness. The progressive degeneration of the school reader, and the simultaneous development of flash literature for the young, has had much to do with the growth of evil tendencies in this field. To direct and utilize, so far as it needs it, this manifestation of the play-instinct, which, though sporting with lies so gracious and innocent, may lead to so many kinds of divorce of thought from reality and of self-deception, the whole question of how best to introduce the young to the best literature of the world, each kind and grade in fit time and proportion, must, we believe, be pondered, and to this problem we shall turn elsewhere. How much of this can best be appreciated in children, and, if its peculiar quality of fancy is once lost, must remain caviare to it, only those know who have realized in their own experience and observation how youthful minds find and play about the chief beauties of ballads, of Homer properly told in English, and of the radical conceptions and great situations in the choicest English writers, if only put in proper form. Psychologically imaginative literature is a direct development from this variety of play, and into this its unfoldment is natural.

VI. A less common class of what we may call pathological lies was illustrated by about a score of cases in our returns. The love of showing off and seeming big, to attract attention or to win admiration, sometimes leads children to assume false characters, e. g., on going to a new town or school, kept up with difficulty by many false pretenses awhile, but likely to become transparent and collapse, and getting the masquer generally disliked. A few children, especially girls, are honey-combed with morbid self-consciousness and affectation, and seem to have no natural character of their own, but to be always acting a part and attracting attention. Boys prefer fooling, and humbugging by tricks or lies, sometimes of almost preternatural acuteness and cleverness. Several, e. g., combined to make, what seemed, a very complex instrument with cords and pulleys and joints, called an "electrizer." Boys not in the secret were told to press smartly on the knob and they would feel a shock, when there was only a hidden pin. This is the normal diathesis which developes girls into hysterical invalids, deceiving sometimes themselves and sometimes their relatives, most on whom faith-curers work

genuine miracles, and which makes boys into charlatans and impostors of many kinds. It is hard for many to believe that certain women who fulfil their social and domestic duties creditably, can, with such placid naïveté, relate long series of occurrences which they know to be utterly false, and that men they meet are indulging a life long passion for deception, that they love the stimulus of violent ruptures with truth, or love lies for their own sake, as victims of other intoxicants love strong drink. The recent literature of both telepathy and hypnotism furnish many striking examples of this type. Accessory motives, love of applause, money, etc., are at first involved, but later what we may designate as a veritable *pseudomania* supervenes where lies for others, and even self-deception is an appetite indulged directly against every motive of prudence and interest. As man cannot be false to others if true to self, so he cannot experience the dangerous exhilaration of deceiving others without being in a measure his own victim, left to believe his own lie. Those who have failed in many legitimate endeavors learn that they can make themselves of much account in the world by adroit lying. These cases demand the most prompt and drastic treatment. If the withdrawal of attention and sympathy, and belief in the earlier manifestations, and if instruction and stern reprimand are not enough, there is still virtue in the rod, which should not be spared, and, if this fail, then the doctor should be called.

VII. Finally, children have many palliatives for lies that wound the conscience. If one says "really" or "truly," especially, if repeated, and most solemnly of all, "I wish to drop down dead this minute, if it is not so," the validity of any statement is greatly reduplicated. Only a child who is very hardened in falsehood, very fearful of consequences, or else truthful, will reiterate "it is so anyhow," even to tears in the face of evidence he cannot rebut, while others will confess or simulate a false confession as the easiest issue. Only young children who mistake for truth whatever pleases their elders, or, occasionally those too much commended for so doing, find pleasure in confessing what they never did. To say yes, and add in whisper, "in my mind," meant no, among the children of several schools at least in one large city. To put the left hand on the right shoulder also has power, many think, to reverse a lie, and even an oath may be neutralized or taken in an opposite sense by raising the left instead of the right hand. To think "I do not mean it," or to mean it in a different sense, sometimes excruciatingly different from what is currently understood was a form of mental reservation repeatedly found. If one *tries* not to hear

when called, he may say he did not hear, with less guilt. An acted lie is far less frequently felt than a spoken one, so to nod is less sinful than to say yes; to point the wrong way when asked where some one is gone, is less guilty than to *say* wrongly. Pantomimed lies are, in short, for the most part, easily gotten away with. It is very common for children to deny in the strongest and most solemn way wrongs they are accused of, and when, at length, evidence is overwhelming, to explain or to think, "My hand, or foot did it, not I." This distinction is not unnatural in children whose teachers or parents so often snap or whip the particular member which has committed the offence. In short, hardly any of the sinuosities lately asserted, whether rightly or wrongly, of the earlier Jesuit confessionals, and all the elaborated pharmacopœia of placebos they are said to have used to ease consciences outraged by falsehood, seem reproduced in the spontaneous endeavors of children to mitigate the poignancy of this sense of guilt.

In fine, some forms of the habit of lying are so prevalent among young children that all illustrations of it, like the above, seem trite and commonplace. Thorough-going truthfulness comes hard and late, and school life is so full of temptation to falsehood that an honest child is its rarest, as well as its noblest, work. The chief practical point is for the teacher to distinguish the different forms of the disease and apply the remedies best for each. So far from being a simple perversity, it is so exceedingly complex, and born of such diverse and even opposite tendencies, that a course of treatment that would cure one form, would sometimes directly aggravate another. If we pass from the standpoint of Mrs. Opie to the deeper, but often misconceived one of Heinroth, and strive to realize the sense in which all sin and all disease are lies, because perversions of the intent of Nature, we shall see how habitual falsehood may end, and in what in a broad sense it begins. A robust truth-speaking is the best pedagogic preparation for active life, which holds men up to the top of their moral condition above the false beliefs, false fears, and false shames, hopes, loves we are prone to. The effort to act a part or fill a place in life for which Nature has not made us, whether it be school-bred, or instinctively fascinating to intoxication as it is for feeble, characterless, psycho-physic constitutions, is one of the chief sources of waste of moral energy in modern society, lies, acted, spoken, imagined, give that morbid self-consciousness so titileting to neurotic constitutions. The habitual gratification of all a child's wishes indirectly cultivates mendacity, for truth requires a robust and hardy self-sacrifice,

which luxury makes impossible. Much society of strangers where "first impressions" are consciously made, favors it. Frequent change of environment, or of school or residence, favors it, for a feeling that "new leaves" can be easily turned arises. Frequent novelties, even of studies, probably cultivate one of its most incurable forms, viz., that state of nerves where the first impression is strong and vivid and pleasurable, while repetitions are indifferent, if not soon positively painful; a condition which, but for multiplying the already large number of mild manias, might be called *neomania*. Children should be shielded from both the professional mendacity and the false exaggeration of the abnormal of the modern newspaper, and held to long and firm responsibility for their acts and words. When men or civilization, yet capable of it, give up the lie and fall back to their best and truest selves, to be and to be accepted, from what they really are by nature and heredity, one of the highest and most intense of all pleasures is realized, which, though narrowed and conventionalized by many religious and dogmatic systems, is very manifold and may appear as general moral reformation, new intellectual insights, emotional easement and satisfaction, greater energy in action, and perhaps even greater physical betterment in certain forms of disease in certain temperaments, and, in a word, is still from the standpoint of scientific psychology, not unworthy the grand old—but greatly abused term—Regeneration.[1]

ED.

[1] Much of the material here reported owes its value to the tact and indefatigability of Miss Sara E. Wiltse one of the collectors.

A SKETCH OF THE HISTORY OF REFLEX ACTION.

I.

Introductory.

A number of the phenomena, normal and especially morbid, which we now group under the physiological category of reflex action, are noted in the earliest medical literature. The Hippokratic writers not only knew of a general consensus between different parts of the body—such as that existing between the uterus and the breasts—but in their sections on the sacred disease, or madness, it is easy to see that various forms of reflex cramps, although wrongly understood, had been often observed.

Galen even describes correctly the effect upon the aperture of the pupil, of closing and illuminating the eye, and treats of diseases and abnormal symptoms which arise from "sympathy." The history of medical studies, before the great anatomists of the sixteenth century had demonstrated the existence of nerves as distinct from sinews, records many instances of "sympathy," mediated, it was often said, by the blood-vessels. Some of these are purely fanciful, some are due to other causes, but not a few are true reflexes. It is impossible to approach our subject without asking at the outset why the simple rubric of reflexion, which now explains so much, was not suggested by the phenomena so often observed before the second quarter of our own century. The answer is not, however, far to seek. Besides the meagreness of anatomical knowledge, there was a deeper and more generic cause, suggested by the very word "sympathy." It was the belief in an immaterial psychic principle pervading the whole body and mediating freely between its parts, *without necessitating a direct connection of tissues.* This general notion which long prevented any adequate conception of reflex movements, and which, as we shall see later, is still cherished by a few uncritical scientific men, is no less universal and spontaneous than language itself, in the earliest known forms of which it is so manifoldly seen. It is nothing more nor less than spiritualism, or animism, beginning, as it naturally does, in the form of psychological dualism, at first with the suggestion of a refined essence, intangible as a shadow, separable from the body in dreams, vital as the breath, finally surviving death and endowing animals, plants, inorganic things, and even the

elements of the world itself, with a distinct animating, if not a free and more or less conscious principle. The supposed subtle operations of this principle have been often characterized. It will answer our purpose here merely to recall to mind a few not unfamiliar historical *motifs*, which we wish might serve to broaden the narrow and conventional lines wrongly followed in the so-called "history of philosophy."

In the rudimentary physiology and pathology of nearly all the Greek philosophers, the *pneuma* or *psyche* plays the chief rôle. Plato, the great protagonist of all modern animistic philosophizing, conceived the soul, as, at the same time, the principle of life, and as independent of the body. It thought in the head, felt in the breast, and desired in the belly. It was closely connected with the world-soul, while over the material world the *idea* reigned supreme. Aristotle, who may be said to have given form to the mediæval Christian philosophy, and especially to its psychology, as well as to have first taught the development theory and the doctrine of the powers or faculties of the soul, recognized a nutritive soul in plants, a sensory soul in animals, and a thinking soul in man. As the principle of life, it was inseparable from the body, while the thinking *nous* was immortal. It was the sufficient cause of all the phenomena of life. Its chief seat was the heart, and it was mediated by fire, air, or ether. The Stoics, the pneumatic school of medicine, and even Galen believed the body pervaded through all its faculties by vital or intelligent forces. The cabalistic systems of emanation, which so effectually extinguished medical knowledge and art after Galen, taught that demons, once united near God, fell, and now pervade all nature, giving it harmony, "as the human body is pervaded by sympathies." Diseases, especially those of the nervous system, were ascribed to the presence of devils. The physician must not so much study magic, which was suspected, as science came to be later, but must struggle up by prayer, asceticism and extasy to gain the theurgic power of exorcism by knowledge of and living union with the omnipotent, spermatic Word of God. Meanwhile, devastating plagues and fantastic neural diseases—lycantrophy, obsession, dancing and self-scourging manias, and the children's crusade, which Hæser, in his history of epidemic diseases, well describes as a "psychic pest," were explained on this principle.

Cardanus taught that there was a sympathy between certain parts of the body and certain planets. Paracelsus, whose vagaries overthrew the authority of Galen, asserted that the soul itself had a soul, and that had another, and so on to the fifth potence or the quintessence. He taught the existence of a sidereal and an astral, as well as a material body, and

assumed a conscious vegetative principle or *archæus*, which separated the good and the bad in food, fed the various organs and kept them at work, and must occasionally be roused by medicine or otherwise from forgetfulness of its duties. According to the Rosicrucians, medicine rests on a knowledge of universal harmony. Plants suffer our diseases, and all diseases have their real seat, not in the material organism, but in an animating principle. Thus the sympathy of medicines, of which they wrote, was no mere metaphor to their minds. Not only was the existence of a panacea, as the counterpart of poisons universally deadly, asserted, but it was assumed that all diseases had at bottom one occult, immaterial cause, and must also have one cure, which was to be spiritually sought, discerned and applied. Thus medicine was connected with Christology. Croll asserted that all nature was alive, and nothing was dead. Man is made after the pattern of the firmament. All that exists in the world at large—even minerals and plants—exists also in microcosmic man. Every herb represents a star and every star an herb; and the doctor who is regenerate by the light of divine grace knows the magnetic star-lent influences by which all medicines work, and the mysterious signatures in accordance with which they must be applied. Later it was said that every organ had its vital part. We even read of a vital astronomy; and all nature was animated by sympathies and antipathies. As Geulincx declared that mind and body were so distinct and opposed that they could affect each other only through a divine mediation, so Helmont taught that no medicine could take effect save through "the gracious compassion of God." Disease, it was repeatedly urged, was not merely an accident or a substance, but a struggle of the vital forces against the invasion of a morbid species or principle. Near the end of the seventeenth century, many of these conceptions were combined in the influential theory of Stahl, that the soul must be assumed as the one only immaterial and active principle in the body, the latter, as material, being absolutely passive. Every physiological process and movement whatever is the work of this rational and intelligent, although not always conscious or reflective soul. Fever, e. g., Stahl regarded as the excreting, secreting, circulatory processes of a sound soul resisting some noxious agent or activity, and as impossible in animals because they have no soul.

The influence of such conceptions has, fortunately enough for the human race, ceased for the most part to influence the theory or the legitimate practice of medicine, although they are common and potent enough among uneducated and quackish physicians. In the natural philosophy of Schelling and

Oken, the spiritualistic conception obtained a very strong hold of the popular half-cultured mind, which it still fascinates in the form of Hartmann's exposition of the Unconscious, in Hæckel's speculations about the cell-soul, etc. Here too, as we shall explain later, we believe the theories of Whytt and Pflüger, and their rehabilitation by G. H. Lewes, must eventually be classed. That chapter of it which treats of nervous functions has been longest and most dismally obscured by the same class of superstitions which science has had to oppose in some form at every step of its progress. It is plain that if corporal functions are mediated by immaterial agencies, physiological science is impossible. If, between a stimulus and the reactionary movement in the leg of a freshly decapitated frog, any sort of a sensory or volitional process is interpolated which is different from, or can in the least degree affect the train of mechanical or chemical activities in the tissues, it follows that just in that degree all inferred laws concerning the action of reflex centers can be only conjectured as far as their more broadly philosophical bearings are concerned. These spiritualistic superstitions were indeed opposed not merely to the principles and methods of science in general, but were eminently inconsistent with such fundamental schematisms as sensation and motion, feeling and will, stimulus and reaction, etc., the slow development of which by the Montpelier school and elsewhere gradually paved the way for a neuro-psychology which came to regard reflex action as the element, rudiment, type or unit of mind.

Again, it was frequently said that sympathies were mediated by the blood vessels. This seems like at least an attempt at a physiological explanation. This doctrine was, however, closely connected with early spiritualistic conceptions on the one hand, and with an erroneous conception almost universally held, in some form, for nearly a score of centuries, on the other. In the first place, in dead animals the arteries being found nearly empty were thought by the ancients to be filled from the lungs with air or ether, as their name indicates. Ether, according to the extended and influential Pythagorean school, was the highest and purest part of the air, the medium in which gods, planets and immortal souls live serenely, in eternal motion. Demokritus taught that the psychic nature was inhaled constantly from the air. The soul of man was thus called a product or part of the world-soul. Diogenes made air the first element, and said that life and thought were given in or with it. The Hippokratic school explained, further, that, after reaching the arteries, the ether passed to the brain, where it left the "bloom of its forces," increasing sensibility and mobility, and thence flowed to other parts of

the body, which are vital in proportion to the nearness of their vascular relation to the brain. By a curious confusion of the two stand-points, the brain, and not the heart or diaphragm, as many supposed, was made the seat of feeling and knowledge, while at the same time it was regarded as a gland that cooled and tempered the heat of the heart by secreting phlegm which, if its passage downward and outward was checked, caused epileptic cramps, *tetanus*, *spasmus*, *cynicus*, madness, and a disease which seems to have been *tabes dorsualis*.

Hence, it was inferred that such diseases, which have played so important a part in the early history of religion, were no more holy than others, need no expiation and are cured, not by magic, but, like all diseases, by applying the counter-cause. Hence, too, the great influence ascribed to winds, weather, and the location and frontage of houses, to which so much space is devoted by this school, in a fashion so eminently sanitary and in accordance with the customs and climatology of Greece, and which can be traced in astrological vagaries that haunted therapeutics for many centuries. The "powers of the air," the rushing wind or *spiritus*, the higher pneumatic nature of man, concentric airy spheres peopled with more and more heavenly natures as the soul ascends, and many other widely current conceptions of primitive psychology, show how deeply inwrought was the notion of an airy, etherial soul pervading the whole body, no less effectually than the blood-gasses in the processes sometimes grouped together by modern physiology as "internal breathing." Plato thought taste was mediated by small blood-vessels which pass from the tongue to the heart, and hearing by the motion of the air being carried over into the blood. While the brain was spongy, moist, and the seat of cold which tended downward, the heart was the source of heat and fire which tended upward, to prevent the too lavish efflux of which the eye-lids were designed. From the notion of the sacredness of blood as a medium of the soul, came the subtleties of the pulse-feelers, who distinguished a score of fantastic kinds of pulse from which they practiced divination, as was later done with the urine of which nineteen colors were distinguished, as well as the sixty species of fevers described in the fifteenth century.

Again, sympathies were mediated not by the blood directly, but by animal spirits secreted from it in the ventricles of the brain, the systole and diastole of which caused them to circulate along the nerves through the body. One mediæval anatomist describes the optic nerve as having the form of a hollow tube, so that the visual spirits might pass, carrying the ideas from the air and idola from objects to the brain. Such conceptions, gathered almost at random, will suffice to

illustrate the general psycho-physic notions which prevailed until Harvey, in the first half of the seventeenth century, demonstrated the circulation of the blood, and which for a long time prevented the acceptation of his theory. Even when he urged that in the embryo, at least, blood and not ether must circulate in the arteries, it was replied that one, as well as the other, could be derived from the mother. It was far easier, one antagonist urged, to conceive fine meshes in the walls of the heart, perhaps closed after death, through which air entered from the lungs, than to imagine the fine, invisible capillaries which Harvey assumed all over the body, connecting arteries and veins.

Toward the end of the sixteenth century, before Harvey had made his observations, the opinion began to gain ground among anatomists, that the sympathies were mediated by the nerves which were beginning to attract great attention. This was in some sense established by Willis, who was the best anatomist of the seventeenth century. Where two parts of the body were in sympathy, he inferred that they were connected by nerves instead of by blood-vessels. This opinion was current for a long time. A glance at the neurology of this period will suffice to show that, although much was done by the great observers whose names are preserved in the nomenclature of the brain, they were very far from attaining to any adequate conception of the functions of a nervous center, or even of nervous fibres. But a few decades before Willis wrote, one observer had urged with great vigor the Aristotelian theory that the nerves took their rise from the heart, because the soul, being one, could have but one seat and that must be the heart, which was the first point of motion in the impregnated egg, and was immediately affected by every emotion.

The arteries, which conducted nervous energy from the heart to the brain, had a nervous envelope, and after their cavities had united in the brain, their walls divided as nervous threads. Although the animal spirits were secreted from the blood of the *choroid plexi*, Servetus said the proper seat of the soul was the aqueduct of Sylvius. The first and second ventricles, he explained, received images from the external world; the third was the seat of thought, and the fourth of memory. The cortex and convolutions of the brain were neglected, the base and centre attracting chief attention, in spite of the old notion that the outer membrane enclosing it, in which it was long thought the cerebral nerves in part took their origin, was essential to psychic processes. When Fallopio urged that only the optic nerve was enclosed by a membrane of the dura mater, it was for a time thought that this

was a peculiarity of sensory as distinct from motor nerves. Long, and sometimes bitter, was the controversy, whether the optic nerve was really hollow, that the visual spirits might reach the eye; whether the brain had more veins than arteries; whether it was a gland and the glands nervous; whether nerves contracted and relaxed; whether the cerebellum had nerves of its own; and at what point the soul was most probably located. The *corpora striata*, according to Willis, was the seat of sensation, while the activity of the soul was chiefly concentrated in the *corpus collosum*, on the surface of which ideas were mirrored as on a white wall. A whitish nervous sap is the vehicle of the animal spirits. Others, influenced by Newton's discoveries, argued for a solidary structure of the nerves, and the theory of nerve-vibration, analogous to the undulations of ether, was generally adopted by English physiologists. On the one hand, it was urged that the vessels about the circle of Willis were the centre of sensation, and the *dura mater* was that of motion; while in Italy it was thought that the latter enclosed four ventricles like the heart, and was the centre from which nerves proceeded, like the blood-vessels from the heart; and finally, that it was loose enough to beat like the heart, as its analogous fibrous structure indicated. Thus all the movements in the body which were effected by nerves were ultimately caused by the force imparted to them from the *dura mater*, the movement of which aided the circulation in the brain, secreted the nerve juice and diffused it throughout the nervous system, and the extreme sensitiveness of which indicated that it was the seat of all sensation. It was reserved for Haller to demonstrate that the *dura mater* was immovable, insensitive, and was not the origin of nerves. Thus sympathy or consent, although rightly located in the nervous system, was not much nearer a correct explanation than when it was thought to be mediated spiritually, or through the blood-vessels.

A fourth theory, more important for our theme, took its origin in the epoch-making discovery of the father of German physiology, Haller, which properly dated with his communication to the Göttengen Academy, in 1752. He had tested a great number of tissues and organs, and found that the irritation of some caused sensation, and that of others caused movement or contraction. Only those parts which contained muscular fibres could contract, while nerves were not irritable because they could not move. He found that muscles were irritable some time after they were separated from the body, and compared the contraction of the fibers of the heart caused by the blood, with that of the voluntary muscles, caused by the will. Irritability he found constantly present in the

muscles while nervous force worked through the will, the result being the same in both cases. Hitherto every force tolerated in the animal body had been either closely analogous with known chemical or mechanical forces, or else had been regarded as more or less spiritual. Haller analyzed the hitherto inexplicable functions of motion, and found an elementary power inherent in muscular fibres, which was always present and aroused by irritation, and which had no parallel in inorganic nature. Haller was moderate and rational, and regarded irritability only as a power peculiar to and inherent in muscular fibres. The long discussion of his discovery that followed, and which for a time eclipsed nearly every other question in medical science, equals, if it does not exceed, in vagaries the philosophical speculation consciously and unconsciously suggested or fashioned upon the demonstration of magnetism and electric polarity. Whytt declared that all parts of the animal body were sensitive, whether containing nerves or not; and that the so-called irritability was a psychic activity. Some feared a rehabilitation of occult qualities in the doctrine of irritability. Some thought that all muscular action depended on nervous fluid or the *vis nervosa*. One writer said that only nerves could excite the vital molecular activity of contraction, and not a few argued that diseases were caused by means of medicines working upon irritability. Irritation and stimulus henceforth became dominant conceptions in pathology.

Gaub distinguished the soul, to which he ascribed not only the instincts but even respiration and vital force, and defined the latter as the power by which living matter contracted under the influence of irritation. Living matter is matter that can contract and feel, and an irritation he explains as that which, by contact, excites vital force to action. In his Pathology, however, he uses the word irritability in quite a different sense, as increased activity of the vital force, and as such, opposed to torpor. Vital force, he argued, was something unique and not to be sought in the elements of organisms, for these could still subsist when it was gone. It was not even to be confused with the electric or nervous fluids, which two latter some identified. Barthey added to irritability in muscles a "dilatation-force," and regarded their rest as active. Gregory thought irritability was to be distinguished from nervous force only by its seat, and, besides a dead elastic force in muscular fibre, described a third "tonic force," which resisted their relaxation. Schäfer regarded sensibility as independent of its material basis and essentially identical with vital force, while irritability depended upon it. Some located irritability in the solid, others in

fluid parts of the body. Many said everything which can react is irritable, thus extending the notion to the whole body; while scores of speculations for which we have no space and the reader would have no patience, were freely indulged in.

Haller's conception of irritability rested upon the phenomena observed in the heart, which he supposed to be without nerves. This error was natural enough when we consider that the nerves of the heart are so small that only the most accomplished microscopists can trace them. Only one observer seems rightly to have understood, and to have effectively contributed to the development of Haller's conception of irritability. Fontana, in his classical experiments, published in 1775, demonstrated the difference between irritability and elasticity (which continued its oscilations after the cause was removed) on the one hand, and the *vis nervosa* on the other. He showed that every stimulus diminished, while rest increased, irritability. He agreed with Haller that the nervous agent was the exciting, but not the immediate and sufficient cause; that in most cases it acted as the external excitor of the irritability of the muscular fibre. By the discoveries of Galvani, near the beginning of the present century, attention was called to the phenomena of nerves acting under electrical stimulation, and the important question whether muscles were irritable without the mediation of nervous fibres, was demonstrated after the effect of *curara*, which destroys the action of nerves upon muscles was discovered, independently and about the same time, by Kölliker and Claude Bernard. This we may regard as a triumphant vindication of Haller, whose work resulted in exorcising from muscles—the last excited element in the "reflex arc"—the mystic notions of vital force, and in opening up the broad and fruitful field of myology to scientific methods.

Although Haller had found that certain parts, such as the pleura, the bronchi, etc., responded to stimulation neither by sensation nor motion, another important result of his experiments was to cause functions and parts to fall into two great categories, one sensory and the other motor. This important dichotomy, which still underlies most conceptions of reflex action, also began at once to play an exceedingly conspicuous part in medical and philosophical theories. The notion of vital force was, in fact, as some complained, divided into two principles. Sensibility was paralleled or contrasted with irritability at every point. The mystics and followers of Stahl substituted motility, or perhaps, like Borden, voluntary motion, as the second term of the two elementary physiological phenomena. Many translated irritability in the freest and loosest way, as the power of reacting upon outer impressions of

all sorts. Even subjective phenomena, such as pain, reflexion, etc., were characterized as higher manifestations of irritability. In the system of John Brown, which became so influential on the continent, excitability was said to be located in nerve and muscle substance, and was defined as the property of being called into self-activity by the action of external stimuli; and was made the specific, though otherwise unknown, characteristic of living matter. The latter tends at every point and movement to fall into its simpler elements, but is forced to continue the processes which constitute vitality by external activities ever incident upon it in all directions. Too much of the latter causes hypersthenic; too little, the asthenic diseases. Life is thus reaction, and all its processes are made up of stimuli, excitability and excitement.

The only physiological fact upon which this class of speculations rested was the observation that the stimulation of certain nerves seemed to cause only sensation, and that of others only motion.

The discovery of the Voltaic pile, with its negative and positive pole, was immediately seized upon with the greatest avidity, and became the fundamental category, now in more now in less disguised or conscious form, for a mass of medical and philosophical speculation. Life, it was said, was analogous to, if not identical with electricity, and the intellectual world seemed to fall apart into the quaint electric dualisms of active and passive, male and female, day and night, thought and feeling, acid and alkali, etc., etc. Many preferred to regard the universe as made up of triads. Oxygen, hydrogen, and carbon were often suggested, but under the influence of Blumenbach, and especially of Schelling, the triad, reproduction, irritability, sensibility, as ascending potencies of the absolute, revealed successively in the ascending orders of animal life, gradually unfolded into speculative forms which Humboldt well designated as the saturnalia of natural science. Hegel is preëminently indebted to Volta for his unique dialectic method of affirmation or position, negation, and mediation or indifference-point. Meanwhile, medical art and science gradually decayed in Germany until, in 1830–40, they were, by general consent, in worse condition here than in any enlightened country in Europe, while animal magnetism, cranioscopy, and homœopathic vagaries sprung up, grew rank and struck deep root in soil in which, if anywhere, only minute and painstaking investigations of the physical conditions of health and disease should be cultivated. Only for the fundamental dichotomy of sensation and motion was solid physiological ground won later by the great discovery of Charles Bell, that the posterior spinal nerves were sensory, and the anterior nerves motor.

It will help us to understand another element of the greatest importance for our theme to go back to the seventeenth century and to remember that, as Plato is the philosophic father of most spiritualistic tones of thought, so Des Cartes may be said, in general terms, to have introduced into the modern world that form of dualism which has superseded Platonism, and proposed the fundamental problem with which philosophy has been so largely occupied ever since, viz., the mediation between mind and matter, soul and body, thought and being. We will not here pause to trace out the repressing effect which the metaphysical theories which centre about the theory of knowledge have had upon legitimate psychological studies. It is important, however, not to forget that Des Cartes was led chiefly by the exigencies of his system—according to which mind as thought could have nothing in common with matter as extension, and must, therefore, be brought into a forced union with it—and partly by his physico-mathematical tastes and studies to describe the body as a machine, and that this characterization had great influence upon minds of an empirical order. Great and preponderating as were the powers he assigned to the soul, the limitation of its seat to a single part, and the relegation to it of only those activities within the body not strictly mechanical, was a step of great importance. Besides this, Des Cartes' whole habit of mind, his inability to think, save with visual and mathematical concepts, his physical conception of physiology and the form and nature of particles were, no doubt, of much direct and indirect influence in forming the mechanical, or so-called iatro-mathematical school of medicine. A more direct stimulus to this school was given by the brilliant demonstrations of Galileo, while Harvey, Bacon, the revival of fine arts in Italy, and the unfruitfulness of chemical-humoral conceptions expressed and strengthened the tendency it represents.

The modern mechanical school of physiology was founded by Borelli, whose chief work on The Motion of Animals appeared in 1670. The bones he described as levers, and the swelling of muscles by the nervous fluid propelled into them from the brain was the motive power. He estimated how much force is lost by the unfavorable purchase of muscles, and compared the force used by different muscles. He first demonstrated that the act of breathing was a process in which the lungs are purely passive, and analyzed composite motions with a thoroughness unsurpassed till Weber. The movement of the blood he referred to static and hydraulic principles, tried to estimate the force of the heart's movements, and knew that it was greatest in the lateral walls, while the apex was comparatively motionless. Even digestion, he inferred from

the stomach of birds, consisted largely of detrition, while he calculated in pounds the powers of the walls of the stomach. Secretion he considered as a process of sifting depending on the different diameter of small vessels. Borelli's pupils, like their master, restricted themselves to the most familiar natural forces and mechanical principles, in their attempts to explain organic processes. Hoffman, who also studied mathematics as a preparation for medicine, in establishing this school in Germany, added to the ordinary material elements the hypothetical ether which Huyghens had just introduced. Besides permeating the blood, ether has its own peculiar circulation through the nerves. This fluid moves and is governed by the central *anima*, strictly in accordance with higher mechanical laws, which are, however, not yet well understood. Hoffman's speculations concerning the animal ether, which he expressly identified with the sensory soul, gave his system a dynamic cast inherited directly from Leibnitz, whom he admiringly studied, and this tended greatly to obscure the mechanical principles, upon which he always insisted, and to give his teachings, which have had great influence in Germany, some points of analogy with those of Stahl, his famous adversary. As the nervous system became known and gradually assumed a supreme position among the tissues, many mechanical conceptions of the processes which underlie its functions were expressed in place of the old idea that nerves contracted and lengthened in occasioning motion. They were sometimes said to vibrate like the strings of a harp; or the molecules within them were thought to oscillate; or their subtle fluids to mingle with others by diffusion. Irritability, one writer explained, was a modification of general attraction; and others thought nutrition and excretion were due to attraction and repulsion.

Part of the energy of the mechanical school went to seed in the shallow writers of the *erclairissement;* some of it can be traced in monographic works on light and vision, etc., while among many wiser observers the conviction gained ground that chemistry and mechanical science were not yet sufficiently developed to explain the more recondite processes of organic life, and they naturally turned, therefore, to the purer and broader forms of theoretical empiricism represented by Bacon and Locke, and to the development of the practical side of their respective professions. During the present century, however, mechanical methods have attained a remarkable development in the German experimental school of physiology which has recreated the art and science of medicine in that country, equipping it with manifold thermal, electric, hydrostatic, surgical and other apparatus and

methods, and enriching the world with the multitude of facts grouped under the names neuro and psycho-physics, physiological optics and acoustics, myology and physiological chemistry. Very prominent among the important physiological conceptions of this century is Marshall Hall's theory of reflex action, which first introduced a mechanical principle to explain the functions of the nervous centers of the spinal cord. The discussion of this most important conception we must reserve for a later chapter.

Here, however, belongs a brief reference to one of the most interesting of all attempts to interpret physiological processes by the aid of physical principles. The phenomena of animal electricity were first studied in a part of the reflex apparatus of a frog. If they have not explained all that was once hoped, it was these studies which first introduced exact methods into the investigation of the functions of the nervous system. With the collapse of mesmerism in the French revolution the many speculations which had been rife concerning the relation between the magnetic and vital phenomena were quickly forgotten until in 1791, a new direction was given to physiological physics by Galvani's conception that the animal body, pre-eminently the nerves, was the seat of a peculiar and independent sort of electricity, probably secreted chiefly in the brain. He believed the inner substance of the nerves to consist of a very subtle and fluid lymph peculiarly adapted to conduct electricity, and which was inclosed in a non-conducting substance. This electricity was stored up in the muscles as in Kleist, or Leiden jars, to which the nerves were the conducting wires. The outer surface of the muscles was negative, their inner surface, where the electricity accumulated, was positive. Motion was caused when this fluid was drawn from the interior to the exterior of the muscles along the nerves so that the cause of every contraction is like the discharge of a Leiden jar, the negative surface fibres of the muscles being peculiarly irritable. Although this theory was not strictly in accordance with the facts he had observed, the greatest popular interest was again aroused. "Wherever there were frogs," says Du Bois-Reymond, "and wherever two scraps of heterogeneous metal could be found, every one sought to see for himself the miraculous re-animation of mutilated limbs. Physiologists believed their ancient idea of a vital force had become tangible, and physicians, influenced by Galvani's too facile attempts to explain all sorts of nervous diseases,— sciatica, tetanus and epilepsy,— thought no cure hence forth impossible." Volta, who was already an experienced electrician, easily demonstrated that the electricity which Galvani had at first observed came from metals and

not from the animal. The former had the best of the controversy until Galvani found that when the sciatic nerve was brought into contact with the muscle a contraction occurred without metals. Volta still insisted that the current was not pre-existent in the animal, but was developed by the contact of different fluids in the tissues. After repeating the experiments of Volta and Galvani with many variations, Humboldt came to side with the former, and although his observations fill two volumes, they add little that is new in fact or valuable in theory.[1] In 1799, the year after Galvani's death, Volta discovered the pile which bears his name. His erroneous contact theory, (that whenever two heterogeneous substances are brought into contact one of them assumes a positive and the other a negative electrical condition), absorbed scientific interest, and galvanism was forgotten. The frog-pile was discovered, and many attempts were made to explain animal electricity by physical hypothesis.

At last, after applying Ampère's astatic double needle to Schweiger's multiplicator, which gave a far more delicate test for detecting the presence of electricity than had hitherto been known, Nobili, in 1826, demonstrated the frog-current which Galvani lacked the physical apparatus to do. The muscle and nerve, or the head and feet of a frog, each immersed in a tiny cup containing salt solution, into which the wires of the multiplier were introduced, caused a permanent deviation of the needle, demonstrating a constant current from the muscles to the nerves, and from the head to the feet of the frog. This current he believed to be of thermo-electric origin, flowing from the warmer to the colder part.

The subject was taken up and advanced by Matteucci (to whom Du Bois-Reymond, in the historical sketch just referred to, does much injustice), by Valentin and Reymond himself. The electrical properties and processes in nerves and muscles, at rest and in action, has now become one of the most complicated of physiological problems, while the pre-existence of the current in the natural condition of the tissues, which Reymond advocates, and his hypothesis of polar molecules arranged longitudinally through nerve and muscle fibers like a series of magnets to explain the phenomena of electrotonus and the development of the electrical current, are rendered very questionable by the experiments of Hermann and Englemann. In 1850, ten years after the publication of Reymond's investigations, the time of the transmission of irritation along nervous fibers was first measured, and found to be so great that all thoughts of identity or parallelism of electricity and the nervous energy efficient in sensation and motion—a con-

[1] Versuche über gereizte Muskel- und Nervefasern. Berlin, 1797.

ception which had considerable influence in inspiring and directing investigations up to that point—had to be abandoned. The wave of negative variation of the neural current, which moves only about 28 metres per second, is now considered as merely the accompanying sign or exponent—and the only one we have—of a series of processes which constitute every nervous impulse, the ulterior nature of which is as yet inscrutable. Even the nature of the processes of muscular contraction which, besides the far slower negative wave, is attended by thermal, chemical and dioptric, as well as molar changes, is as yet only conjectural.

The application of electrical stimuli to animal tissues has proved the most fruitful of all physiological methods, and it seems at first strange that its use in reflex studies should have been so very recent, and scarcely less so, that, during the earlier investigations of galvanism, the phenomena of reflex action should have attracted so little attention, although it is evident from causual reference that it was often observed. The reasons it is hoped will become apparent as we proceed. Meanwhile we may observe that it is the exact mechanico-empirical method that has accomplished everything, almost without exception, that has been done in the field of physiology. Just so far as experimenters have added explanations and theories to their demonstrations, their work has crumbled and been forgotten, while just so far as they directed and confined their labors to the pure and clear presentation of typical facts and their conditions, in such a way that others could readily find and reproduce them at will, their contributions have been useful and permanent.

A new physical method is the most important contribution that can be made to science, and through it to the sum of human knowledge and happiness. This is no less true of neurological than of other studies. Diseases have been classified in genera and species like plants, according to the medicines which it was thought were salutary, according to the most elaborate schedules of subjective "symptomatic" feelings, according to the organs they affected, according to *apriori* philosophical schemes, but a true natural basis of classification was reached only when the forms of cell-change or decay peculiar to each was known. In a scarcely less rude and uncritical way psychic faculties and processes have long been classified, and if the latter are ever to be soundly based on the varieties of structure and process in the nervous elements or substrata, while we shall then feel surer of our knowledge of them and have a method of study which may reveal much now undreamed of, only those most deeply versed in mechanical aspects of things and in the capability

of physical methods, can understand how unaffected they must forever leave all the ideal *goods* which those who comprehend them least profoundly so often think imperiled.

The rapidity with which nervous processes traversed the nerves was thought by the physiologists of the last century to be analogous to that of light or else of lightning. Some said it was as much more rapid than the blood as the nerve fibers were smaller than the aorta, and some argued that it must be absolutely independent of time. Haller falsely assumed that between every two contractions the way between muscles and the brain must be passed and repassed, and estimated this rapidity at 9000 feet per minute. As late as 1844, Johannes Müller wrote "we shall never have the means of measuring the rapidity of nervous processes, because we can never compare immense distances from which the rapidity of a process in the nerves, in this respect analogous to that of light, can be computed;" and again, "the time in which a sensation-process from the periphery to the brain and cord, and the reaction upon the peripheral parts by contraction follows, is infinitely small and immeasurable." One of the earliest achievements of Helmholtz, however, was in measuring these rapidities. Although his apparatus, compared with that now in use, was very imperfect, his result—that irritations are propagated along motor nerve fibers at the rate of 27.75 metres per second—was tolerably accurate. Most of his experiments were made by stimulating the sciatic nerve of a frog at points alternately near and far from its entrance into a muscle, which recorded upon a swiftly revolving drum the movement when the resulting contraction began. The effect of this discovery upon the conception of the nature of nervous action in general was great. Helmholtz wrote "as long as physiologists thought themselves compelled to refer nervous processes to the diffusion of an imponderable or psychic principle, it might seem incredible that the rapidity of the current within the short distances of the animal body should be measurable. Now we know from the investigations of Du Bois-Reymond on the electromotive properties of nerves, that that activity which mediates the propagation of an irritation is at least very closely connected with a changed arrangement of their material molecules, in fact is perhaps essentially conditioned by it. According to this the conducting of impulses in nerves would fall into the class of self-propagating molecular processes of ponderable bodies, such as, e. g., the transition of sound through the air and elastic substance, or the gradual burning of a fuze." ED.

PSYCHOLOGICAL LITERATURE.

I.—NERVOUS SYSTEM.

Ueber Faserschwund in der Kleinhirnrinde. ADOLPH MEYER. Archiv f. Psych. u. Nervenkrankheiten. Bd. XXI, H. 1; mit 1. Taf.

The network of fibers in the granular layer of the cerebellar cortex was the portion examined by the author. The loss of fibers here was found to take place to a varying extent, and for convenience he distinguishes those cases in which it is slight, medium, and excessive; specimens were stained with Weigert's Hæmatoxylin. He then cites fifteen cases which he has himself examined. Dividing these according to the degree of degeneration of the cerebellar fibers into three groups, they form: Group I, Case 1. General progressive paralysis; in which degeneration was slight.— Group II, Cases 2–6 inclusive. Three of these were general progressive paralysis, one melancholia with stupor, one chronic paranoia. Degeneration medium.— Group III, Cases 7–14 inclusive. Seven of these were general progressive paralysis, one dementia senilis. Degeneration excessive.

The 15th case (idiocy) falls outside of any of these groups, being most probably a case of arrested development. The prominent characteristic in these cases was dementia. There was always a loss of fibers in the cerebral cortex—and the loss in the cerebella cortex appeared to follow on that in the cerebrum, and to be a slow process. The cause is entirely obscure, but the course of the fibers involved is taken to be through the middle peduncle of the cerebellum to the pons, and so to the cerebrum. The author looks forward to pursuing the investigation more in detail.

(The apparently close relation thus developed between the cerebral and cerebellar cortex, and association of degeneration of the fibers with dementia in this general way, are both facts of great value.—REV.)

Recherches sur la localization des conducteurs des impressions sensitives dans les diverses parties de l'encéphale et sur la pathogenie de anesthesies de cause encéphalique. M. BROWN-SEQUARD. Archives de physiologie, etc., No. 3, Juillet, 1889.

The author opens with the following propositions:

1. Each half of the brain is able to perceive sensory impressions arising in the two halves of the body. 2. The sensory elements are so distributed in the brain that sensation remains even when a large portion of the two halves of the brain has been destroyed. 3. The transmission of sensations still occurs even when the cord has been completely severed by two hemisections at different levels and on opposite sides, provided they are sufficiently distant from one another. 4. If we attribute the anaesthesia following organic lesions of the brain or cord to loss of function in the part injured, we are compelled to admit absurdities. . . . . As a matter of fact clinical experience shows that anaesthesia may or may not appear whatever the location of the organic lesion. 5. Anaesthesia, due to brain lesions, may occur on either or both sides when the lesion is single, or on one side when the brain lesion is double, or may disappear while the brain lesion at the same time becomes more extensive. 6. In the case of partial organic brain lesion the anaesthesia is therefore not due to the loss of function in the

nervous elements destroyed, but to an action of the lesion on the nervous matter about it causing inhibition of the sensory apparatus. This is a dynamic process, hence subject to great variation, thus giving rise, under different conditions, to very various results.

As evidence for the above from the experimental side, he presents the results obtained from dogs in which lesion of the internal capsule, lateral portion of the base of the brain, or superior part of the cervical cord was followed by hyperaesthesia of the corresponding, anaesthesia of the opposite side. If, now, a hemisection of the cord be made on the side opposite to the initial lesion (at the level of the last dorsal or first lumbar vertebra) the anaesthesia and hyperaesthesia change places. In these experiments anaesthesia is most complete after section of the internal capsule, and diminishes according to the parts operated, in the following order: pons and lumbar cord; cerebral peduncle and cervical cord; medulla. Passing to the clinical data he divides his material (1) into cases with direct anaesthesia and (2) those with both direct and crossed anaesthesia, due to a lesion of one side only. For (1) he gives 59 cases, and for (2) some references to the literature of the subject. He adds that several investigators have found that anaesthesia of cerebral origin disappears on faradization of the skin.

The clinical evidence presented for this view is certainly open to the objection of not being critically collated. Supposing the experimental facts to be correct, the mere statement that the phenomenon is one of inhibition amounts simply to the statement that something does not occur, and as it stands is no explanation at all.

Der Hund ohne Grosshirn. Prof. GOLTZ. XIV Wanderversammlung südwestdeutscher Neurologen und Irrenärzte, Mai, 1889. Original Bericht von Dr. L. Laquer.

Goltz communicated his observations on a dog which had lived 51 days after the removal of his fore-brain. The fore-brain on both sides was removed together with corpora striata, leaving only a small remnant about the brain-axis between the optic tracts. The thalami were of course secondarily involved. The remaining portions of the stem were soft and but poorly sculptured. The important point was that the dog lived so long a time after such an injury, and could, moreover, stand, walk and rise on his hind legs. He could not eat or drink alone but could chew food put well back in his mouth. Waking and sleeping alternated with him as with a normal animal. When hungry he was restless, when satisfied he slept. He could be waked by touching him at any point of the skin. He then opened his eyes, previously closed, and stretched like a normal animal on waking. If the limbs were put in an uncomfortable position he moved back to the normal. As occasion demanded he could whine, growl, bark and howl. Evacuating faeces or urine he took the positions of a normal dog. To sound he did not react. The senses of smell and sight were wanting because the nerves were sectioned.

Ueber das Rindencentrum für die Stimmbildung. ROSSBACH. Jahressitzung des Vereins der deutschen Irrenärzte. Jena, Juni, 1889. Abstracts of communications in Neurolog. Centralbl., No. 13, 1889, by Bruns.

The patient had symptoms of compression in the caudal cervical region, which at autopsy were found as due to a tumor. Further there was on the left side paralysis of the facial, atrophy of the tongue and paralysis of the vocal cord, of ten years standing. The autopsy showed a so-called *encephalitis subcorticalis* of the right inferior parietal lobe, of the posterior central convolution, where it helps to form the operculum, and of the posterior convolution of the island of Reil. In the medulla the nucleus of the hypoglossus was alone atrophied, whereas the nuclei

of the facialis, vagus and accessorius with their nerves, also the recurrent and the muscles of the larynx and vocal cords were all intact. The paralysis of the vocal cord and of the facialis on the left is therefore connected with the cortical lesion in the right hemisphere, and that of the vocal cord is associated with the defect in the island of Reil or neighboring portion of the parietal lobe.

Ricerche anatomo-comparative sulla distribuzione delle arterie nella superficie encephalica di alcuni mammiferi. R. STADERINI. Atti della R. Accademia dei Fisiocritici, Siena, Serie IV., Vol. 2; 1889.

For the determination of the superficial distribution of the cerebral arteries, the sheep, horse, dog, cat, rabbit, monkey and man were examined. In man and the monkeys the anterior cerebral artery supplies the two olfactory convolutions, the median portion of the orbital convolution, the entire mesial surface of the hemisphere cephalad of the medial portion of the parieto-occipital fissure, together with the superior frontal and half of the middle frontal convolutions and all of the superior parietal convolution. The middle cerebral artery supplies the remainder of the convexity of the hemisphere including the outer face and extremity of the temporal lobe, as well as the island of Reil. It may further send a branch to the middle portion of the occipital lobe. The posterior cerebral artery supplies the entire surface of the temporo-occipital lobe and the medial and lateral faces of the occipital lobe. In the other animals examined the anterior cerebral supplies the greater part of the olfactory lobe, (except in the case of the horse, in which the cephalic third of the olfactory lobe and a part of the frontal lobe are supplied by a cerebral branch of the opthalmic artery), the portion of the brain to which the cephalic extremity of this lobe is applied, the mesial face of the hemisphere, (except a small portion at the caudal extremity,) and the part corresponding to the sagittal convolution. The middle cerebral artery supplies the lateral and ventral faces of the hippocampal lobe and the entire lateral face of the hemisphere, with the exception of the sagittal convolution and the extreme caudal portion of the hemisphere. The posterior cerebral artery supplies the mesial face of the hippocampal convolution, that portion of the surface which lies over the cerebellum, and finally the most caudal portion of the hemisphere.

Ein Hydrocephalus ungewöhnlichen Umfangs. Dr. F. TUCZEK und Dr. AUGUST CRAMER. Arch. f. Psychiatrie und Nervenkrankheiten. Bd. XX. H. 2. 1889. 1 Taf.

The authors give an unusually thorough and concise statement of the appearance and dimensions of both skull and brain in the case of a hydrocephalic patient, the horizontal circumference of whose head was 75 cm. Patient, a male, was normal at birth, but during the first year the head became noticeably large and the lower extremities failed to develop normally. At the age of 29 years he became an inmate of the Landeshospital Haina, where he remained until his death from decubitus suddenly developed, in 1887. The physical examination made at entrance into the hospital showed him normal and fairly developed, save in the two particulars just mentioned. The animal functions were good. He was cleanly, good-natured, free from delusions, could speak slowly, but at the same time clearly, and could sing, had a good memory, for persons at least, though he had had no mental training, never having attended school. In general was rather weak minded; showed no sensory disturbances and could use his hands well, even for sewing, etc.

The skull was found of considerable thickness. Dura adherent to the roof. The latter was thick and heavy. In removing brain 1850 cu. cm. of fluid were collected, after which the brain, with remaining fluid, weighed 1600 grams. The horizontal circumference of the fresh

brain was 67.5 cm., and the greatest breadth 20 cm. Hemispheres with thin walls which collapsed on withdrawal of the fluid. The main portion of the specimen was hardened in bichromate and preserved in alcohol, while small portions of one hemisphere were prepared by other more special methods. The gyri were unusually long and broad, well rounded, though but slightly prominent, the sulci very shallow. The lateral ventricles were enormously enlarged; the hemispheres thin-walled, and showing at places on the internal surface ridges of medullary substance. Corpus callosum and fornix were represented by the merest remnants; the septum lucidum by its pedunculi. The third ventricle was much enlarged, and the soft commissure was wanting. The hemispheral wall was from ½ to 4 cm. thick; the cortex 2—3 mm. thick. A centrum ovale did not exist. Careful measurements are given of the basal ganglia, interbrain, midbrain, hind-brain, and after-brain—all symmetrical. A microscopical examination of the cortex by the methods of Exner and Weigert showed a normal development of the fibers, save that those of the first (zonal) layer were unusually slender. The ganglion cells were abundant and no change in them, even in the motor regions, could be determined. The pathological changes in the crura and parts lying caudad were the complete obliteration of the central canal and degeneration in the pyramidal tracts. The great slenderness of the first layer of cortical fibers is explained as the result of stretching. The cortical speech center was incompletely developed. The secondary degeneration of the pyramidal tracts was associated with the loss of the subcortical medullary substance, as has been shown in other cases of hydrocephalus, with paralysis and contracture. Degeneration in the cord mainly affected the fibers for the lower limbs, as was to be expected, and with this was also associated the very poor development of the central gyri in their dorsal third.

Ueber Hirngewichte bei Geistesschwachen. WULF. XXIII Jahresversammlung des Vereins Hannover'scher und Westphälischer Irrenärzte zu Hannover, Mai, 1889. Abstracts by Bruns in Neurolog. Centralbl., No. 10, 1889.

The result of weighing 205 brains of idiots and imbeciles is given as follows:

1. Average weight in men greater than in women. 2. Average weight in cases of mental weakness is less than in any other form of mental disease, except, perhaps, general paralysis in women. 3. In mental weakness the brain reaches its maximal weight earlier (earlier too in men than in women) than in normal individuals or those suffering from other forms of mental disease; the decrease in weight also commences earlier. 4. The weights of the fore-brain have the same relation as those of the entire brain, both in men and women. 5. The weight of the cerebellum is abnormally small, and small, too, relatively to that of the fore-brain and the entire brain. 6. In relation to the size and weight of the body the weight is as in normal persons, *i. e.*, in general the brain weight increases with the size and weight of the body. On the other hand, there is relatively an inverse relation in that persons of small body weight have a relatively heavier brain and *vice versa*. The same is true in relation to the height. 7. Epileptics with mental weakness have a smaller brain than those not epileptics. Measurements of the head showed that mental weakness was strongly associated with brachycephalic skulls.

Ein Beitrag zur Kenntniss der feineren pathologischen Anatomie der Idiotie. H. KÖSTER. Neurolog. Centralbl., No. 10, 1889.

A brief review of the literature of the anatomy of the brains of idiots is followed by a short account of K. A. S. whose arrested development

led to idiocy. Death at twenty-six years. Makroscopically the brain showed nothing abnormal. The cortex from different portions was examined microscopically. The abnormalities here found were: increase of neuroglia substance; distention of the perivascular and pericellular lymph spaces, atrophy of a number of ganglion cells, also pigmentary degeneration and vacuolization of many of them, and especially and particularly irregularity in the position of the pyramidal cells both with reference to the other layers and with reference to one another; finally hypertrophy of the vessels. The hypertrophy of the connective tissue and the atrophy of a number of ganglion cells were certainly pathological changes. The pigmentary degeneration in the case was also pathological for normally there is no such deposition of pigment in a person so young. The vacuolization was present, but whether pathological or not, the author leaves undecided. The displacement of the pyramidal cells certainly existed during life. Köster then balances the evidence in this case for and against the existence of enlarged pericellular spaces during life and concludes from the fact that there is an abnormal tendency for the pericellular spaces in many cases to fuse with one another, thus bringing two cells within one space, that the appearance is pathological and not an artefact. Of all these peculiarities there is only one, namely, the displacement of the pyramidal cells, which is not found in other forms of mental disease. This displacement consisted in a deviation of the cells, without uniformity, by which the long axes, instead of being vertical to the cortical surface and nearly parallel to one another, came to lie in any position with reference to this surface. Such an arrangement has been observed in other cases by Betz and Bernhardini, and the author points out that this variation should be particularly looked for in similar cases in order to determine the constancy of its occurrence. The paper has two figures showing ganglion cells, lymph spaces and vessels. ("*Azencylinderfortsatz*" is the word used to designate the conical prolongation of the pyramidal cells. REV.)

Beschreibung dreier Mikrocephalen-Gehirne nebst Vorstudien zur Anatomie der Mikrocephalie. Abtheilung I. Dr. F. MARCHAND. Nova Acta d. Kaiserl. Leop.-Carol. Deutschen Akademie der Naturforscher. Bd. LIII, No. 3. Rev. in Neurolog. Centralbl., No. 12, 1889, by P. Kronthal.

A careful study of these three cases showed the following abnormalities.

In the first: Forebrain small; great simplification and flattening of the convolutions, especially in parietal lobes. Central fissure running at right angles to the great longitudinal fissure with apparent union of the central fissure on the left side with the fissure of Sylvius. Marked development of the "Affenspalte" *(sulcus occipitalis transversus)* with well developed *operculum occipitale;* rudimentary development of the first and second occipital convolutions, which present well formed bridging convolutions as in the lower monkeys. Union of the *fissura calcarina* with the *sulcus ammonis;* excessive development of the gray matter on the convexity of the forebrain, specially of the parietal lobe and anterior central convolution with concomitant diminution of the white matter. Anomalies in the medulla oblongata in the abnormal arrangement of the gray matter of the olivary bodies in the form of several secondary olives. Moderate distention of the ventricle.

2. This specimen showed the forebrain small; great simplicity of the convolutions; exposure of a portion of the island of Reil, with incomplete development of the operculum. Central fissure nearly at right angles to the great longitudinal. The long axis of the parietal lobe, small; union of the parieto-occipital fissure with the *sulcus occipitalis transversus*, forming a deep depression between the parietal and occipital

lobes. The superior portion of the first *gyrus occipitalis* sunken, with incomplete development of the *tuberculum occipitale*. Cuneus, small. Corpus callosum, dwarfed.

3. The main deviations from the normal here were: Forebrain very small; great simplification of the convolutions. Exposure of a portion of the island of Reil. Union of the right central fissure with fissure of Sylvius; complete separation of the anterior central convolution on the right side from the horizontal frontal convolutions by an abnormally developed praecentral sulcus. Occipital convolutions small and abnormally formed. Presence of an *operculum occipitale*. Abnormal formation of the parieto-occipital fissure, especially on the right side. Shortening of the corpus callosum caudad. Five good plates accompany the text.

Variations of the spinal nerves in the caudal region of the domestic Pigeon. JAMES I. PECK. Jour. of Morphology, Vol. III, No. 1. June, 1889. 1 Plate.

The author first determined that the variable number of caudal vertebræ was not altogether explained by union of one or more with the coccyx, for if this had been the case an inverse relation was to be expected between the length of the coccyx and the number of caudal vertebræ. It was, however, found that the coccyx was longer in those specimens having many than in those having few free caudal vertebræ, and although the relation of the most caudal one of the latter to the coccyx varied, being more or less anchylosed with it, yet the variations in this part of the skeleton are thus shown to be more than relative. Specimens were examined by direct dissection and by sections—dove-cote and fantail pigeons being employed. In various specimens from 5 to 8 free caudal vertebræ were found. This gave from 6 to 9 spaces for the emergence of nerves. In general the number of nerves was equal to the number of spaces minus 2, but it was sometimes equal to the number of spaces minus one. In one case, also, the most caudal nerve was present apparently on one side only. Caudad, at the point where the nerves arise, the cord is continued as a filum terminale, the arrangement of the nerves preventing anything like a cauda equina. The conclusion is that the nervous system in this region is plastic, and varies in association with the number of caudal vertebræ.

Anatomischer Befund bei einseitigem Fehlen des Kniephänomens. A. PICK. Archiv f. Psychiatrie und Nervenkrankheiten. Bd. XX. H. 3, 1889.

The spinal cord examined in this case was from a man of 60 years dying of pleuro-pneumonia while under treatment for tabes and dementia paralytica. In the fresh cord there was makroscopically nothing abnormal. When hardened in bichromate of potash the posterior columns were plainly seen to be degenerated through the entire length of the cord. The maximum disturbance was about the juncture of the dorsal with the lumbar regions. Here, as in the other regions, the left side was more involved than the right, and specially the root zone of the left side was more degenerated than that of the right, though there was some degeneration on the right side also. The knee jerk on the left side was absent in the patient, and on the right could be obtained with re-enforcement only. Westphal had already associated the loss of the knee-jerk with disease of the root zone (*Wurzeleintrittzone*) at the level of union between dorsal and lumbar regions; and this case is presented as confirmatory of his results. It will be observed that the localization is of a lesion in a tract of fibers and not of a cell group.

Histologische Untersuchungen am Rückenmark der Tritonen. K. R. BURCKHARDT. Archiv f. mikros. Anatomie. Bd. 34. H. 1, 1889.

Triton Alpestris was the form mainly used in this study, and one principle object which the author had in mind was to determine whether the development of the spinal cord took place in a manner similar to that described by His for man. The conclusions support those of His. The mitoses which give rise to the spongioblasts of these authors take place earlier than those which form the neuroblasts—the first form of nerve cells. The supporting substance of the cord is essentially epidermal, therefore, though, in the adult, cells of a different nature may be found imbedded in it. The ganglion cells are of several sizes, and it is the largest ones that develop earliest. Structures which have been described as "granules" and "free nuclei" are, in some cases at least, small ganglion cells. Triton also shows large nerve cells which are the homologues of the "posterior cells" (Freud) in Petromyzon. The plates that accompany the paper show several cross sections of the cord, and it is remarkable how closely the early stages resemble the developing cord in man.

Ueber den oberen Kern des Nervus oculomotorius. Dr. L. DARKSCHEWITSCH. Arch. f. Anat. u. Entwickelungsgsch. January, 1889. H. I. and II. Taf. I.

By the study of cross-sections from the region of the anterior corpora quadrigemina in the human fœtus, between the seventh and eighth months, Darkschewitsch makes out a group of cells to which he gives the name superior nucleus of the oculomotorius. The following is taken from his description: There are in this region two columns of cells on each side, their long axis parallel to the aquæduct. The more ventral and caudal group lies nearer the middle line, the more dorsal and cephalic one being laterad of it. The latter group has much smaller cells than the former. In their relations to the oculomotor nerve fibers and the posterior longitudinal bundle, both groups are alike. It is this dorsal and cephalic group, composed of the small cells, which is the "superior nucleus" of our author. For its relations, see the original paper. (Gudden has already described the several cell clusters which form the oculo-motor nucleus in the rabbit, and it may be that a study of this superior nucleus in the adult human brain will make it possible to homologize the subdivisions in man and the rabbit. In the meantime it must be remembered that this "superior nucleus" is classed with the oculo-motor centre solely on the ground of juxtaposition and its relation to the posterior longitudinal bundle and the oculo-motor nerve.—REV.)

Multiple Hirnnervenläsion nach Basisfractur. Ein Beitrag zur Frage des Verlaufs der Geschmacksnerven. L. BRUNS. Archiv f. Psychiatrie, u. Nervenkrankheiten, Bd. XX, H. 2, 1889.

The patient was a man who had been thrown from a wagon violently on his head; several cranial nerves (from II–VII inclusive) were injured by what was diagnosed as fracture of the basis of the skull. The careful examination showed that in general there existed on the right side, on which there was total paralysis of the facialis, a complete hemiageusia, both at the tip and back of tongue and soft palate, while on the left side, on which the trigeminus was completely paralyzed sensibility to taste was everywhere retained. There was no evidence that the glosso-pharyngeus was injured other than was furnished by the loss of taste. It was further surmised that the trigeminal lesion was intracranial, while that of the facial was in the Fallopian canal. If the hemiageusia had been confined to the anterior two-thirds of the tongue, the case would have fitted nicely with the theory of Carl, which makes the course of the taste fibers from the glosso-pharyngeus—where they arise—through the ganglion petrosum and by the tympanic nerve to the tympanic plexus, from here the main portion passes by the nervus

petrosus superficialis minor to the ganglion oticum and so to the lingualis, while the smaller part of the fibers passes from the tympanic plexus by a communicating branch to the geniculate ganglion of the facial, along this nerve to the chorda tympani and by the chorda to the lingualis. In Bruns' case the right temporal bone is probably fractured and the tympanic plexus can very well have been injured by this, thus well explaining part of the facts. The puzzling feature of the case is that the ageusia occurs on the back of the tongue as well, which is generally considered to be innervated directly by glosso-pharyngeal fibers and that there is no other evidence of glosso-pharyngeal injury. Bruns makes the suggestion that if the nervus intermedius is considered with Lussana and Vulpian to contain the nerves of taste for the back of the tongue, in addition to those for the other gustatory regions, as maintained by the above authors, this case may perhaps be explained, but he urges no hypothesis and presents these observations more as a contribution to the discussion than as decisive on any points.

Sur le nombre et le calibre du fibres nerveuses du nerf oculomoteur commun, chez le chat nouveau-né et chez le chat adulte. M. H. SCHILLER. Comptes Rendus. 30 September, 1889.

Under the direction of Forel, Schiller has made some interesting observations to test whether the nervous elements increased in number after birth. The test was made by counting with care the number of fibers in the cross-sections of the oculo-motor nerves of some new-born cats and comparing this number with that found in the cross-sections of the same nerve in the adult animal.

The average number of fibers, taken from 3 cats, new-born, gives,	2942
For 2 cats, 4 weeks old, (same litter,)	2961
For 1 cat, 6 weeks old,	3032
For 1 cat, 1 year old,	3046
For 1 cat, a year and a half old,	3035

The slight increase in the number of fibers for the older animals is fairly accounted for by the greater ease of counting the elements in the adult, for the diameter of the fibers in the new born lies between 1.5—2 μ., while in the case of the oldest specimen—a year and a half old—it varies from 6—20 μ. The conclusion, as pointed out in a note by Forel, is to show plainly that cell multiplication in this nerve centre has stopped at the time of birth. The work is to be continued with the view to finding whether, as the present views demand, each nerve fiber is represented by a nerve cell.

Ueber die Histologie des Centralnervensystems. FROMMANN. Jahressitzung des Vereins der deutschen Irrenärzte. Jena, Juni, 1889. Abstracts of communications in Neurolog. Centralbl., No. 13, 1889, by Bruns.

First concerning the structure of the axis cylinder in nerve fibers. There are three views: Kupffer assumes continuous fibrillae running the entire length of the fiber; Joseph, a network with fibrillae passing between the meshes; Heitzmann, cross anastomoses which interrupt the direct tracts in the axis cylinder. From the study of invertebrates, Leydig supports the last view and explains the cross anastomoses as a supporting structure, which being interrupted cannot conduct. The conductive substance is the hyaloplasma, enclosed by this supporting substance. If this is true, how explain the conducting in the fine terminal branches of nerves where there is no hyaloplasma? Leydig describes in nerve cells, pale stripes and lines of hyaloplasma which conduct the nervous impulse from the cells. Frommann could not find these. He

described then in detail the form and fibers of the nuclear framework of the ganglion cell. For the most part these form a network and pass out of the cell as fine fibers. The arrangement is particularly plain in the *ganglion stellatum* of the cuttle fish. These fine fibers unite, in this case, the cell with its capsule and the cells with one another. Against Leydig's view that the life processes are associated with the hyaloplasma is the fact that during life the fibers and their nodal points continually change their form. That such changes represent a normal process is probable.

Nouvelles recherches sur la constitution cellulaire de la fibre nerveuse. L. GEDOELST. La Cellule. T. V., 1er Fasc., 1889. 1 plate.

The discussion in this paper is centred on the reticular portion of the medullary sheath. Gedoelst has previously published on this topic, and has convinced himself on the following points: First, there exists a reticulum which has been described successively by Ewald and Kühne, and by Lautermann. Second, the neurokeratine network of the former is identical with the network of the latter. Third, this network is preformed and not merely a result of the reagents used. Fourth, the threads of the network are impregnated with lecithine, while cerebrine occupies the meshes. The present paper deals first with the clefts of Lautermann. These are not preformed in the sense that they are plainly visible in the normal nerve, but are preformed in the sense that at the points where they appear there are distinct peculiarities of structure in the sheath. These peculiarities point to the existence of a substance which swells with ease, thus separating the myeline into segments and exposing at one stage the threads of the network. As a rule the swelling goes so far that these threads are broken. The surface of the cones thus formed with the encircling ridges Gedoelst identifies with the "spiral fiber" of Golgi and Rezzonico, which he looks upon as an artefact. His second point is the relation of the parts at the nodes. The axis cylinder is continuous, as is also the sheath of Schwann. So far as the latter is concerned the fiber may be considered to have a structure analogous to that of a filamentous alga for example, in which the outer cell wall is continuous despite the fact that from it arise the cross-partitions which divide the filament into segments. This cross-partition in the case of the axis cylinder is a delicate membrane constructed like a cribriform plate through the holes of which the fibrillae pass. Only the most delicate manipulation serves to preserve this plate, and all the other relations of the parts at the node are but deformations of this structure. A good bibliography of the recent works goes with the paper.

Weiterer Beitrag zur Kenntniss der Golgi'schen Untersuchungsmethode des centralen Nervensystems. Dr. L. GREPPIN. Arch. f. Anat. u. Entwickelungsgsch.—Supplement-Band, Nov., 1889. 1 Taf.

The material employed was mainly the human cerebrum and cerebellum. To the silver method of Golgi, Greppin has added a technical point which cannot fail to be useful. The silver stained section is floated in a 10 per cent. solution of hydrobromic acid. By this treatment the silver deposit turns white by reflected light, while by transmitted light it still appears black. The pictures thus obtained are as sharp as with the silver alone, and the preparations, besides being permanent can be mounted under a cover glass, and further can be treated subsequently by a number of methods. So far as staining is concerned, the author finds a final treatment by Pal's modification of Weigert's haematoxylin method by far the most instructive. It is also found that, after the section has been treated with a 10 per cent. solution of hydrobromic acid, if it then be put in a 40 per cent. solution of the same, the

silver deposit is slowly dissolved out, leaving the cellular elements more or less clearly marked. From a study of such sections, Greppin arrives at several conclusions of interest. So far as the results of Rossbach and Sehrwald go, he agrees with them in viewing the place where the silver deposit is made as the lymphatic system of the brain. By his method he further finds some coloration of the nervous elements themselves. In matching the pictures of the lymph spaces about the nerve-cell with the cell element itself, he has not observed lateral branches from the axis cylinder process filling the lateral lymph spaces which have been taken to indicate the existence of such branches. He therefore looks on the axis cylinder prolongation as unbranched. Connections either between nerve cells by any of their prolongations or between the nerve cells and fibers he has not seen, though he believes the latter to exist. In the most densely stained specimens there is always a portion not stained, which he identifies with the ground substance of the older histologists. The periglial spaces form a connected system, and he assumes that the contained glia cells thus constitute a network of varying density in the meshes of which the nervous elements are to be found. The general aim of the paper is to show that by the application of Golgi's method no new facts of fundamental importance have been added, but that the older views have been confirmed.

(Greppin does not appear to have examined any nerve cells the axis cylinder prolongations of which belonged to Golgi's second class, and in which the relation of the axis cylinder to its assumed branches is more important, for in these cells the axis cylinder must either pass into the branching lymph channels or else terminate abruptly soon after leaving the cell.—REV.)

Transactions of the Association of American Physicians. Third session, held at Washington, September 18–20, 1888.

At this meeting of the association one topic chosen for discussion was "The relation between trophic lesions and diseases of the nervous system." From the clinical side the presentation was made by Dr. E. C. Seguin. For his purpose Seguin recast the question in the form: "What are the lesions which may be supposed to be directly produced by disease of the nervous system (brain, spinal cord, and nerves); and what is the essential causal relation between the two factors?" Trophic lesion is understood to mean here a positive histological alteration in the tissue. Seguin distinguishes for convenience two classes. First, those occurring in parts whose sensibility is more or less reduced by nervous disease and which are exposed to the action of traumatic and infectious influences. Second, those occurring in deeper parts apparently not exposed to such influences. In cases of the first class—like ulcerations of the cornea after injury to the trigeminus, the changes in hair and nails and even extensive necrosis and gangrene following section and other injuries of the nerve trunks—it has been found that by careful exclusion of trauma and infection the disturbances can be prevented. Perforating ulcer, arthropathies, etc., which occur in the course of posterior spinal sclerosis, are extremely rare in patients able to avoid over-exertion; while cystitis, which was long considered one symptom of myelitis and injury to the spinal cord, is preventable by the use of aseptic catheters. In the second class, Seguin names neuro-muscular atrophy, and the so-called herpatic lesions of the skin, both he considers as true trophic lesions. The mechanism of these trophic changes is too obscure for discussion. As an attempt to simplify the problem under debate, Seguin calls attention to the following points in his presentation. First: That he has "rejected from the category of trophic lesions all vaso-motor, calorific and metabolic phenomena, as well as mere quantative reductions in tissues and organs; reserving the name for such alterations as

are characterized by demonstrable histological changes." In the second place, Seguin shows that the histological lesions, apparently due to nervous disease, may be divided into two classes: "The first as above described being mere complications having a complex etiology, while those of the second class are really trophic lesions due to disease of the nervous system." Third: Without pretending to throw any new light on the intimate nature of real trophic lesions, Seguin points out that the disturbance occurs in continuous tissues, and finally ventures to suggest "that disease of the nervous system produces true trophic lesions when it interferes with the associated or inter-dependent life of continuous tissues."

From the physiological side a presentation was made by Dr. H. C. Wood. He opened with the proposition: "It is physiologically proven that the nervous system directly affects general nutrition." In support of this Wood appealed to the well-known facts of gland physiology. Next he discussed the evidence from the work of Gaskell and others, to show that there are anabolic and katabolic nerves controlling the heart. Finally, he brought forward the results of his own study on fever to show that the heat production, *i. e.*, tissue change, is controlled by a centre somewhere above the medulla. In speaking of the relations of the nerves to muscles, the motornerves are classed as katabolic, and the belief expressed that anabolic nerves, also, will in the future be found. Having presented evidence to show that the nervous system has the power of influencing nutrition, he passed to his second proposition "that various lesions are the immediate result of previous nerve disease, or nerve injury." Here Wood grouped all the cases considered by Seguin in his paper, but without any sub-division, and considered the evidence to prove the proposition just stated. His third point is that a distant lesion may follow a nerve injury or nerve disease without any precedent disturbance of the local circulation. This statement is supported entirely by evidence that decubitus may occur on the side where sensation only is paralyzed. The fourth proposition is the converse of the third. That "alterations in the condition of the vaso-motor centre are not capable of causing many of the distant lesions which follow injury or disease of the nervous system." This being mainly supported by observations on the ear of the rabbit.

In the discussion which followed, Dr. W. M. Ord of London described several cases of disease of the joints, which in his opinion were trophic.

Dr. H. P. Bowditch called attention to the nitrogenous and non-nitrogenous metabolism in muscle, and suggested that limitation of the term trophic to the former would simplify matters. Dr. David Ferrier touched on the question of a double nerve supply to muscle, and thought the study of the heat and other centres, might throw light on the question. Mr. Victor Horsley communicated the results of some work by Dr. Mott of London. Some nerves of the cauda in monkeys were tied and the femur on that side was found the seat of excessive (katabolic) changes. This is particularly interesting since loss of function and vaso-motor disturbances, both of which are often complicating factors, are in this case quite insignificant.

(There are two points in this matter which may be emphasized, namely, that the weight of opinion and anatomical results are against the view that trophic nerves form a separate class, and that the trophic action may be exerted along the nerve in a direction the reverse of that in which the impulses usually travel; witness all the forms of herpes associated with the posterior spinal roots.—REV.)

II.—HEREDITY AND SEX.

JULIUS NELSON, PH. D.

In this section I shall review certain representative modern discussions that bear upon the theory of heredity. We shall see that the

problems involved are very fundamental and of far-reaching significance for Psychology. Here is the ultimate basis to which students of Psychology as well as of Biology must refer their questions for ultimate solution; it is in fact impossible in this connection to separate the two sciences.

A large share of the discussion of the problems of heredity appertains to the various relations of sex. The importance of the latter subject, as indicated by the vast amount of literature of research and thought bearing upon related questions and the great variety of interests that center here, calls for its treatment in a special section to which the present article may be considered introductory.

The reviews will be presented in the following order. After stating the problem of heredity we consider theories of the constitution of protoplasm and of the importance of the cell nucleus to the problem. Then the subject of variation and the relation of the reproductive cells to the other tissues of the body are considered. This leads to the discussion of the origin of death. Then follows a brief reference to the principles of correlated variation, followed by a consideration of the psychic life of cells and the educability of protoplasm. The section concludes with a consideration of the seat of the soul, and metaphysical speculations on the relations of soul and body.

It is important to get a clear idea of the problem of heredity. Consider the following outline of the conditions of the problem. A complex living being is an organization of protoplasmic cells according to the principle of division of labor. All cells performing the same office in the body are nearly alike in appearance, and their aggregate is termed a tissue. Any cell in a tissue can produce its like by simple self-division into two equal parts. The cells of the reproductive tissues are each capable, when separated from their fellows, to build up by continuous multiplication, a new individual, which is a repetition more or less closely of the parent, both in structure and in all characteristics, including psychological ones. More wonderful yet, while this reproductive cell is building up the new individual a very orderly progress is followed, termed development, *(ontogeny)* which shows stages that map out successively the taxonomic character of the group in which the parent is included, beginning with class and ordinal characters, and leaving off with the specific; that is, *ontogeny is a condensed phylogeny.* That apparent divergence from this law may be accounted for by *cenogeny* or secondary adaptation only emphasizes the law, which in popular terms is that the development of the individual is a repetition of the history of its ancestors. Thus the resemblance of a child to its parent is a broad one, including the whole life history, and in this history all the ancestors reappear in a modified form.

But we must go deeper. The reproductive cell, while in its proper tissue, gave rise to cells like itself when division ensued, but in *ontogeny* the offspring, similarly produced, became differentiated into different tissues. For instance, the first division of the egg cell may give rise to the common ancestor of all the ectoderm cells and of the entoderm cells respectively; and subsequent divisions may be the separation of two great sets of organs derived from the ectoderm or entoderm. In fact, the cases are more complex and not thoroughly made out for any organism. However, when any cell has differentiated to assume its final function it has a limited character and apparently can never function in any other capacity, and apparently can not, or, at least, does not act as a reproductive cell. In some way, then, all the different tissues are represented in the egg.

But the modern zoölogist sees progress. Each individual of the line of ancestry transmitted to his offspring more than he received. In the battle with nature, organs became in some way modified and better

adapted for their purpose. Use strengthens organs, disuse enfeebles them, and even new organs, or at least differentiations of old ones, or a modification of their function may be acquired. Lamarck is the most famous advocate of the idea that such acquired characters tend to be transmitted. The idea is evidently prevalent that the children of one who has exercised his musical talent are furnished congenitally with increased musical abilities.

We must seek in the protoplasm of the egg (or *germ cell)* for structures that bear the impress of powers that represent the whole body. This is the modern form of the old doctrine of evolution which saw in the germ cell a complete miniature of the adult. But we must add that this structure of protoplasm can vary either spontaneously or in response to stimuli definitely or indefinitely.

Perigenesis der Plastidule. HÆCKEL.

Hæckel conceives protoplasm to be ultimately composed of molecular units that are themselves a complex system of vibrating atoms. Every new stimulus modifies and complicates the system. When a cell divides into equal parts the form of vibration of the molecules of the two cells is alike, but now the two cells are no longer acted on by similar forces and their systems become more and more divergently modified through life. Thus may we explain variation and phylogenetic differentiation. When cells divide into differentiated cells of the tissues in ontogeny, there is a splitting of the wave movements into two simpler systems. The increase of protoplasm by assimilation is the impressing upon the food molecules of an identical form of vibration. Finally, in sexual reproduction, which is simply the union of two germ cells from different parents, usually not too closely nor too distantly related, there is a union of systems that differ slightly, and hence a new combination, a new variety; so that in sexual reproduction the offspring never are the complete copies of their parents. It is evident that the weak point in this theory is that we have not the faintest idea how the wave motion is caused to split up in ontogeny according to so definite laws, nor, what is more important, how the conditions of the environment cause the proper variations to take place, that adapt the body to the environment. Then, too, we know that *the environment is of importance in ontogeny* for *not all* the characters of protoplasm are ever brought out in any case. The same person, if he could be brought back to repeat his life history under different circumstances, would appear as a very different individual in the final outcome. Life is full of "latent characters" waiting the proper stimulus to become active. Yet how does this action of the environment differ from the action which causes variation and new hereditary possession? Here is the field for inquiry.

Hæckel attempts to lay the foundations of Psychology by calling the persistence of these vibration-systems in their respective forms *memory*. Ontogenetic development is a rehearsing of the experience of protoplasm when it was in the ancestors, (for every child is but a portion of his parent, so that all protoplasm that is alive dates back to the foundation of the world). All that has been experienced has been retained in this cell memory.

Hæckel goes deeper than any other speculator upon these problems, and in some respects his theory has the merit of simplicity.

Abstammungslehre. NÄGELI.

Nägeli derides the Perigenesis theory and substitutes the "Idioplasm" theory. Not all protoplasm carries the hereditary powers, but that which does may be termed Idioplasm. This plasm is supposed to be distributed throughout the cell in the form of fibres that reach to the periphery of the cell; and whenever cells divide and remain united, the

fibres of neighboring cells are continuous; as, indeed, recent studies in the continuity of protoplasm seem to show. The entire idioplasm of the body is then one immense *reticulum*, and a higher organism is thus related to the outside world as a cell on a larger scale. Any disturbance of the idioplasm at one point is transmitted to distant points. Thus the idioplasm preserves a uniform structure so that all cross sections are similar. But the fibre itself is supposed to be composed of rows of units termed *micellae*. The micellae are alike in a single row, and grow and reproduce in a longitudinal direction only. But different rows are unlike; and the peculiar characteristics of an organism depend on the particular structure which a cross section represents. Furthermore, not all the micellae of the cross section are active at once, but certain layers of them act, and in turn stimulate more internal or external layers to activity, and in this way the orderly succession of the cyclic development of ontogeny may be accounted for. All this has been upset by recent discoveries concerning the cell nucleus. In sexual reproduction the characters of the father appear equally transmitted with those of the mother. These characters are therefore contained in the spermatozoon.

Beiträge zur Kenntniss der Bildung, Befruchtung und Theilung des thierischen Eies. O. HERTWIG. Leipzig, 1876.

Hertwig has shown that the union of sperm cell and egg cell known as fertilization or fecundation, consists essentially in the fusion of two similar nuclei (male and female pronuclei), sometimes the tail of the spermatozoon not even entering the egg. Studies of the production of the spermatozoon *(spermatogenesis)* show that cells (quite similar to those that in the female reproductive organs become ova by growth) in the male reproductive organs after repeated divisions become spermatozoa by direct transformation of the cell protoplasm to serve locomotive purposes, the nucleus remaining in the "head" of the spermatozoon. Kölliker, however, derives the entire body of the spermatozoon from the nucleus. It is certain that a large part of the cell protoplasm is lost, and only that immediately surrounding the nucleus is utilized in the maturation of the male element in the highest animals.

Neue Untersuchungen über den Befruchtungsvorgang bei den Phanerogamen als Grundlage für eine Theorie der Zeugung. STRASBURGER. Jena, 1884.

This observer has shown that in the tube of the pollen grain, when it has sprouted upon the stigma of a flower, a nucleus ("generative nucleus") wanders down and seeks the nucleus of the germ cell of the ovary.

Gruber, and others in studying the sexual unions of the unicellular animals, have shown that there is a dividing up of the nucleus, and in *reciprocal fertilization (conjugation*, or copulation of *ciliata)*, there is a mutual interchange of nuclear material; while in *zygotic fertilization* (similar to the union of ovum and spermatozoon) there is a union of the nuclei to form one nucleus.

Bericht der Naturforchenden Gesellschaft zu Freiburg. Vol. 1, 1886. GRUBER.

Gruber has found that by cutting up stentors, the fragments became regenerated to complete stentors whenever a portion of the nucleus was retained in the segment cut off. This experiment proved definitely that the power of assimilation rests with the nucleus, or at least the nucleus has a necessary control. We may also conclude that the nucleus is not a definite structure like the idioplasm of Nägeli, but is an aggregation of gemmules that are alike; each of which can reproduce itself *ad lib-*

ium, and in each of which, therefore, the hereditary characters rest. *The idioplasmic structure, then, is to be sought for in the structure of the nuclear gemmule.* The above conclusions are much in harmony with many facts observed with reference to cells. Let us more especially recall the complicated phenomena of *Karyokinesis*, or indirect cell-division, in which we see the nuclear granules and microsomata pass through complex evolutions of divisions and conjugations, and, finally separate into two groups so as to give to each daughter cell a similar structure. This is especially seen in the division of tissue cells; and Strasburger and others have supposed that *direct division* results in dissimilar cells, *Karyokinetic*, the reverse. But if we believe the different characters of cells in ontogenetic differentiation are due to a separation of gemmules into corresponding differentiated groups, we should naturally suppose the more complicated process to take place in the latter case. See ROUX: *Bedeutung der Kerntheilungsfiguren*. Leipzig, 1883.

Significance of sex. NELSON. See abstract, this JOURNAL, Vol. I, p. 543.

Nelson has given a different explanation, referring the phenomena to sexual processes. According to this view all reproduction is sexual, but accompanied by different degrees of inbreeding or crossing,—the gemmules being looked upon as descendants of a common ancestor just as are the protozoa that conjugate.

We are now prepared to review the Pangenesis theory of Darwin. *(Origin of Species.)* The germ cells are looked upon as storehouses of gemmules that have come from all the cells of the body. Each sort of cell is supposed to have its special sort of gemmule, and these can indefinitely multiply their kind, and thus build up a cell, but at the same time there tends to be variation in their characters, not in a definite direction nor in response to definite stimuli, but often, of course, through the action of the environment when this is out of adaptation to the animal.

Ontogenetic development is explained as the successive activity of gemmules of the ancestors, which are all represented in the germ cells. Cell-division, resulting in differentiated cells, is accompanied by a conjugation of the gemmules of the next succeeding stage with the gemmules that have developed into the cell protoplasm or are active in the preceding stage. The weak point of the theory lies here. It does not show how the characters of the gemmules, nor how the conjugation of the gemmules, effect the evolution of the so differentiated cells. We should also expect, if the cells are giving off gemmules, that inoculation with the blood of a different animal would be the equivalent of a crossing or fertilization, but Galton's experiments in this direction gave negative results. These experiments, it seems to us, have too hastily been taken to disprove the theory; they appear to give negative proof only. Another objection to the theory has been, that the number of gemmules that must be gathered in an egg must in the higher animals be practically so great as to be unthinkable.

The Law of Heredity. W. K. BROOKS. Baltimore, 1883.

To reduce the number of gemmules needed was the aim of Brooks. If it were not for the fact of variation we could get along with a few gemmules, for then we need not gather up the gemmules from the body, because the germ cells of the offspring are the descendants of the egg of the parent, (true of all tissue cells) and of course have the structure of the ancestral germ cell. If now we suppose that gemmules are given off by cells only when a special stimulus is received, as (e. g., when the environment calls for better adaptation) then these gemmules will vary from their like in the egg and will hybridize the latter, and thus produce

(during development) variation of the organ in question. Furthermore, arguments are marshalled to prove the male animal is more variable than the female. We may suppose a division of labor has arisen, by which the male germ-cell has acquired the special function of storing up gemmules of this sort. The egg is the conservative hereditary factor in sexual conjugation, and the spermatozoon the progressive one. Facts are offered to show that in reciprocal crossing the male exerts a more variable influence than the female.

Die Bedeutung der sexuellen Fortpflanzung für die Selektionstheorie. WEISMANN. Jena, 1886.

This author objects to this theory on the ground that when animals are out of relation with their environment the special organ which is weak is not directly affected, and may even be in harmony with the other organs, (if one organ varies all must vary,) and hence will not feel any special strain. For example, what special strain can there be on the green of a moth's wing which does not match the color of a forest leaf, and thus exposes the moth to the attack of birds. His other objection, that the paternal character is as often masked by the prepotent maternal, due to the more rapid multiplication of the maternal idioplasm, does not seem to touch the point at issue. Weismann thinks that in asexual reproduction there can be no variation, and that variation ensues by the sexual union of idioplasms of diverse natures. Consider how multiform must be the variety of characters combined in each individual. The combinations for only ten generations amount to 1024. If now, slight variations in various directions ensue among the individuals of a species, when these variations are compounded the result must be, by algebraic summation, the continuous increase of special characters along definite lines in the course of several generations. But we ask, how can this be, except the minute variations are, in the majority of cases, in the right direction? Here is the very pith of the problem. There is also another factor left out of account, and that is the matter of sexual attraction, either between individuals or more especially between sexual pronuclei producing "prepotency." May there not be definite laws relating the structure of the two idioplasms about to be united, in a way most advantageous? Among human offspring the best and most beautiful offspring have been supposed the result of love matches, (Finck).

This opens up the whole question of the effect of the reproductive cells upon the soma, the reverse of the one we have been considering. The amount of nuclear material present is conceived as helping the process of self division, and when from any cause, as from lack of nutrition, the nucleoplasm is small, a stimulus to development is given by any sudden accession, as takes place in sexual conjugation of cells. This method, of occasional advantage to the protozoa, has been preserved with the metazoa, as it proved advantageous for producing variation, the protozoa not needing it for this purpose (?) as their body is directly changed by the environment. A further discussion of the question follows in the next paper, also by Weismann.

Die Continuität des Keimplasmas als Grundlage einer Theorie der Vererbung. WEISMANN. Jena, 1885.

Are we to conceive of ontogenetic development and reproduction as a repeated cycle starting with the egg, which produces an indefinite number of generations of cells called the soma; and then some of their ultimate generations becoming detached as eggs? Not at all. We must conceive, rather, that the germinal cells multiply like the protozoa, are immortal and direct descendants of each other, and that cyclically when reproduction takes place, some of the germinal cells divide on the plan

of successive differentiation, and produce the *soma* as an instrument for nourishing and maturing the remaining germ cells. As a matter of fact, in many animals the cells that are to become reproductive or ancestors of germ cells are early to be distinguished in the development, but we need not confine ourselves to this method, for *we get rid of the necessity of a continuity of germ cells by assuming a continuity of germinal plasm.* By germinal plasm is meant the true idioplasm which can differentiate into all the organs of the body. When once differentiated it has lost its generic character by analysis.

Weismann conceives ontogenetic development to be a series of successive simplifications of the idioplasm that is producing the soma, a successive analysis, as above noted, when speaking of ectoderm and entoderm. *But in any cell some idioplasm may remain undifferentiated*, while the remainder differentiates. There is differentiated plasma as well as undifferentiated, even in germinal cells; for the reproductive cells are tissues, and require "*oogenic*" and "*spermagenic*" plasma, just as the tissues in general require "*histogenic*" plasma. But when any cell which contains undifferentiated germ plasm is to take on itself the function of being reproductive, it must get rid of the histogenic plasm, and this is the significance of the polar globules extruded by eggs and the paranuclei found in spermatogenesis. Not till these bodies are formed will the pronuclei unite. Everywhere the process of extrusion of nuclear material is twice repeated, (the first globule itself also divides.) The first globule is supposed by Weismann to be the histogenic (*oogenic*) plasma, the second to be the equivalent of the spermatozoon. Strangely enough, Weismann later (*Ber. Natf. ges. Freiburg*, III, 1887,) discovered that parthenogenetic eggs (such can develop without fertilization) have only one polar globule. It would be interesting to know what takes place in the case of the queen bee, who fertilizes her eggs at will, the unfertilized ones hatching into males. To satisfy the theory these eggs should all extrude one globule, and then if fertilization takes place a second should be given off.

By saying that the second globule is the equivalent of the spermatozoon, Weismann does not think (like Minot and others) that there is one peculiar sort of idioplasm called "male" in the spermatozoon, and a "female" sort in the ovum, and that we can speak of "hermaphrodite cells." The cytoplasmic parts of germ cells have been differentiated to enable idioplasm essentially alike (as alike as are the male and female oyster) to reach each other and coalesce. In all cells that become reproductive, he would say some undifferentiated germ plasm was present, but in ordinary tissue cells produced by differentiated division he emphatically denies the possibility of such a thing. In this regard he opposes Kölliker.

Die Bedeutung der Zellen kerne für die Vorgänge der Vererbung. KÖLLIKER. Zeitsch. f. Wiss. Zool. Bd. 42.

This author conceives the idioplasm of all cells as similar, or in other words, all cells contain undifferentiated idioplasm; and there is no such thing as a differentiational cell division; not but that cells may start on different lines of development, but this is due, not to internal arrangements, but to external causes. It is, therefore, the action of the environment that determines the rôle of a cell. All cells are fundamentally like the germ cells. The problem is the same as that concerning latent characters; a certain environment has produced a definite result with any given sample of protoplasm; a different environment would have produced a different result. In each sex lies latent the character of the species, and the *sex* was determined during development by external causes. Of course, after differentiation has ensued it is practically impossible for involution and a new start in a different direction to

take place. This point is emphasized by Weismann as against Kölliker; but we conceive the principal point at issue between the two thinkers lies in their conception of the relation of cell division to differentiation. To Weismann ontogeny is an analysis, due to inherent mechanical arrangements in the protoplasm. To Kölliker, ontogenetic differentiation, like phylogenetic differentiation, is dependent on external conditions. Kölliker does not push his theory to logical conclusions. He might say: If one of the conjugating pronuclei could be replaced by a nucleus from a brain cell or a liver cell for example, there would be no radical dislocation in the embryonic development. This position appears scientifically defensible; and we could add a second scholium, viz.: That in this experiment any fragment of a nucleus taken without definite shape or size, would do just as well, because the nucleus appears to be an aggregate of a vast number of similar gemmules. But the most important question of heredity, viz., How are the new characters acquired by the germ plasm? is still unanswered. Weismann emphatically disbelieves that acquired characters can be transmitted, or that the germ cell receives anything except food from the body. He is forced to the conclusion, that the germ plasm must vary indefinitely, and that adaptation is due to natural selection simply. It seems to be rash to deny that the body has a definite action on the germ cells. The researches of Gaule and his pupils tend to show that something more vital than food wanders from cell to cell. In this line we have to await further developments. Gaule believes that gemmules make the circuit of the tissues to finally lodge in the reproductive organs. The following author dwells on this aspect of the problem.

Ueber Vererbung. NUSSBAUM. Bonn, 1888.

Nussbaum seems to mediate between the positions of Weismann and Kölliker. He admits that like can produce only like, but germinal matter is probably more widely spread than Weismann believes. In the protozoa, Weismann has admitted that the environment causes characters to be acquired that are transmitted, because here is asexual reproduction by division. But we have seen that the nucleus governs the formation of structures in *stentor*, etc., hence the environment must first affect the nucleus, and we naturally conclude that as the germ cell has the power to produce a soma for its own nutrition, that the same soma is an instrument of mediation between the environment and the germ cell. The fact that the character of the father of the first offspring affects the subsequent offspring of the same mother, but by a different father, (ignored by many theories of heredity) shows that sexual cells are capable of marked and definite modification. In this connection we may mention Sequard's experiments upon rabbits. By artificially produced lesions of the cord, epilepsy was caused; and the offspring of such epileptic rabbits suffered from congenital epilepsy.

Ueber die Vererbung. WEISMANN. Jena, 1883.

By Weismann we are reminded that no disease is inherited, but only the tendency to diseases; this is only a particular statement of a more universal law, that our characters are the particular modes of reaction the body has taken with reference to particular circumstances, and thus the particular form of our features only partially represents our hereditary or idioplasmic characteristics. Epilepsy is not a good disease to experiment with, because it may be caused by a certain weakness of nervous organization due to general malnutrition of the embryo caused by epilepsy (or the nervous disturbance of which epilepsy was the symptom) in the mother. The experiment should be repeated, on the males only, to be valid. Weismann does not hesitate to declare that

there is not known a single authentic case of the inheritance of acquired characters. The pamphlet contains in general the ideas noted above.

Die Thatsachen der Vererbung. ROTH. Berlin, 1885.

We have no opportunity to review the older theories of heredity, and simply refer those desiring abstracts of the more important to the above. The author intersperses critical notices of his own.

Ueber die Dauer des Lebens. WEISMANN. Jena, 1882.

A curious but interesting discussion has arisen between Weismann and Götte concerning the relation of reproductive and somatic cells to the length of life and the causes of death. The former calls attention to the fact that protozoa are essentially immortal. We have a continuous growth of protoplasm, and the multiplication of individuals is due to continuous self-division. Of course myriads of individuals are continuously destroyed, but this is not due to any inner principle of senescence, but to other accidents. In metazoa, however, we have, besides "catastrophic death," a "natural death," which is not original, but has been acquired for the good of the species. Natural selection has fixed the length of life for each species at just those limits that admit of the fullest amount of reproductive activity needed to maintain the species. Slow breeders are longest lived; this law is correlated with a second law that the fecundity of the species or the number of eggs or young produced is dependent in direct ratio upon the liability to their destruction before maturity is attained. Protozoa became metazoa by the products of division remaining in contact to form a colony or mass of cells, among which differentiation of labor was instituted and a certain proportion of the cells were modified to serve the reproductive cells. It was clearly of no use for any but reproductive cells to remain immortal, and hence the power to divide so as to pass less and less germinal plasma into the somatic cells was advantageous and was preserved by natural selection. Weismann also thinks that the somatic cells were impressed with power of limited production, those in long lived individuals having the power to produce a greater number of generations than in the short lived. This appears as a weak point in the theory, for it would be difficult to prove that what is called natural death is not in all cases due to inner catastrophic causes, usually the failure in proper functioning of some vital organ. The fact that tissues can indefinitely regenerate themselves shows that their cells, if they receive proper conditions of nutrition, are practically immortal.

Ueber den Ursprung des Todes. GÖTTE. Leipzig, 1883.

Weismann's paper called forth this by Götte. His thesis is, that death is in all cases fundamental, that protozoa even have to die. The organization of the protoplasm breaks up and is reconstituted in the process known as *rejuvenescence*, in which the unicellular being, after having secreted a case or cyst about itself, lies dormant for a time as if in sleep. In the formation of a colony the cells may be alike *(homoplastic)* or unlike *(heteroplastic)*. The metazoa all belong to the latter group. In the first group reproduction of the body-colony is accompanied by the dissolution of the units, each of which continues its life, and by self-division produces a new colony-individual. But the parent individual has ceased to exist. Is this to be termed death? If so, where is the corpse? The dissolution is to be considered as dependent on the fact that each of the cells undergoes *rejuvenescence*, that they may recontinue to divide, and in so doing produce the new individuals. Among the heteroplasts only the reproductive cells have the chance to form new individuals, but the colony, as in the lowest metazoa, (mezozoa=*orthonectida*, etc.,) breaks up during reproduction, and the few somatic cells

are left as a corpse. In many insects death accompanies reproduction; but in cases where the two phenomena are separated in time, Götte supposes such a separation to have been secondarily acquired. A corpse is a secondary affair and not a necessary adjunct to the process that produces the corpse, and which we ordinarily call death. The individual is not to be looked on alone as the sum of the activities of its constituent units, but rather as the *interrelations* which these units sustain. The same number of cells engaged in the same amount of physiological work may be so differently arranged in two cases as to constitute two very different individuals. *Death is the breaking up of the relations*, and the units may survive. Or, if as in the metazoa, many units depend for their life, on the integrity of the relations subsisting between the different parts of the whole, their organization, too, may be destroyed. Tissue death follows individual death as a secondary or accidental consequence.

We may illustrate Götte's idea by an analogy. Essentially, there is no difference in the idea of death as applied to biology, and as applied to the death of a literary society, when the members agree to disband, possibly to found new societies. If we could feel sure that the analogy is something more than a mere analogy, but at bottom is a universal principle of life, we could gain immensely by a mutual comparison between sociology and biology. There are many terms and ideas common to the two sciences, such as division of labor, development, atavism, colony, etc. Reproduction by self-division might be illustrated by the splitting of a tribe into two. Budding by the founding of a colony by emigration of individuals representing different trades needful in the new colony. Sexual reproduction by the emigration of a single couple, and the gradual *development* (embryology) of a colony, with the differentiation of labor, as the individuals increase in number. The individual in this illustration represents the gemmule. The integrity of the state does not depend on the number of persons, though the amount of its activity and wealth does. Similarly, in the cell, the gemmules may be of like nature and vary much in number. Here the illustration favors the view of Kölliker rather than of Weismann. Although the work of two persons may be different, they are essentially alike in characteristics, and the descendant of any person in a state, could found a similar state if forced to do so by emigration.

Ueber Leben und Tod. WEISMANN. Jena, 1883.

Götte's paper was attacked by Weismann as follows: First, there is no evidence favoring Götte's idea of rejuvenescence in the protozoa. Death can only ensue when cells no longer immortal are produced by ontogenetic development of the germ cells of metozoa. Nothing else deserves the name. Death accompanying reproduction is in all cases catastrophic and due to the strain. This sort of death cannot be inherited and so cannot be established by the action of natural selection. Development is the result of a peculiar method of reproduction (the sexual) that has been acquired because of its advantages. Death itself has been secondarily established as a further advantage. The species is still immortal so long as the germ cells are, and the soma or individual is a subordinate and temporary (cytic) affair, constructed by the germ cells.

We have dwelt on these questions because the interrelation of reproductive cells and body is the most vital in every question concerning sex and sexual functions. Weismann's idea that the whole body stands over against the reproductive organs as the equivalent of one reproductive cell, seems to explain the fact that the extirpation of the reproductive organs, does not destroy the integrity of the individual, or cause death as happens, when for instance, the excretory organs (kidneys) are extirpated. Still, no sharp line can be drawn here, for some

organs like the spleen, can be extirpated without causing essentially different effects from those seen to follow castration. The presence of the reproductive organs, on the other hand, exerts a profound influence on the body. From the standpoint of Kölliker all the organs of the body are morphologically homodynamous while physiologically related as chief and subordinate groups.

In this connection we may briefly refer to another matter which has engaged the attention of morphologists, viz., the question of homologies. It is well known that in the segmented animals the organs of the body are (typically) repeated for each segment so that there is a certain independence in the segments. In many worms a detached segment or segments may reproduce the whole body, and similarly the detached segments are reproduced in the animal from which they were taken. The number of segments also is often indefinite and increases with age. There are animals with the segments alike and others where differentiation has taken place. In all these latter cases, the segments cannot reproduce themselves and their number is fixed. Just as there are cell groups that dissolve to allow each cell to enter upon its reproductive work so there are segmented forms, like the Hydroid *Strobila*, and the Tape-worm in which the segments become separated for reproductive purposes. In the embryology of segmented animals, the segments appear successively as in the *Strobila*. Now if we conclude that metameric segmentation is of the nature of zooid reproduction by division (*strobilisation*) we can easily account for correlated variation, for the egg is the ancestor of a typical first zooid, which is ancestral to all the others, and any hereditary peculiarity of any part of this zooid must appear in all the other segments. If we adopt this view, can we apply the Weismann dictum? Which is the segment that remains undifferentiated and is the equivalent of all the others? Here again, Kölliker has the better of the argument. A study of the growth of *Chara* seems to point to a compromise between the two positions and also serves as a model to show how complicated a structure may be built up by the *repetition of a single mode of division*, of which the law in *Chara*, is: The continuous production, from an apical cell of cells that are each capable of division into two cells, one with the characteristics of the apical cell, the other (the internodal cell) with the powers of indefinite growth without division.

Article "Sex" Enc. Britannica; and Proceedings of the Royal Society of Edinburgh, 1886. GEDDES.

Geddes attempts an explanation of a division of this sort, by considering, that two sets of forces *Katabolic* (those that destroy protoplasm, liberate energy, and effect external work, resulting in cell multiplication) and *Anabolic* (those that build up protoplasm, absorb energy, and effect internal work, or growth) are in a certain balance in life; and there is an alternation between the ascendency of the two sets of forces. An *ovum* is a cell in which anabolism is in the ascendant, and a spermatozoon is one in which katabolism reigns. It is easy to see how the fertilization of the *ovum* leads to its segmentation, on this view. But theories of this nature are only partially explanatory. No theory can be true or even of temporary value, unless it harmonizes with the majority of known facts, and when no one fact is fatal to it.

We have yet to enquire how a division of this sort is determined in exactly the mode needful for the good of the species. Not only do we enquire how are cells divided so as to be different, and what causes this difference, but the great question is how is the response of protoplasm to the action of the environment such as to intelligently adapt the being to the conditions of the environment. When an amœba ascertains from

certain conditions that the pool of water in which it lives is about to dry up, it proceeds to envelop itself in a cyst in which it lies preserved until the next rain. Now we could easily imagine some being *endowed with intelligence* making an automaton that would respond in a similar manner to set conditions. But the amœba can do what no automaton could possibly do. It can adapt itself to new conditions if not too violent a change is made. It can *learn*, it must *experience*, and evolution is its account for the powers already acquired by ancestral experience. Ultimately, in all explanations of heredity, the powers of mind are tacitly conceded and if consciousness and mind in the higher animals are the results of evolution, it must be conceded that mind is present wherever there is protoplasm; and it may well be asked, are not all the properties exhibited by protoplasm (aside from such chemical and physical properties as it possesses in common with all other matter) of such a nature as to require terms borrowed from mental phenomena (*e. g. experience* and *idioplasm*). It is true that the activities of protoplasm are all of a physico-chemical nature and obey the law of the conservation of energy. But the problem of heredity is not primarily concerned with the physiology of protoplasm, but with problems of the origin of species, phylogenetic and ontogenetic questions that are totally foreign to chemical and physical phenomena. It is because of this that the problem of heredity becomes a psychological one, and for this reason psychology and biology are so intimately related; just as soon as phychology becomes a matter of research, rather than speculation, it needs the prefix *physiological*. In this connection consult:

"*La vie psychique des micro-organismes*" in *Études de psychologie experimentale*. Paris, 1888. Also translated by Thomas McCormac. Open Court Publishing Company, Chicago, 1889.

As higher animals are congeries of cells and we may believe that the psychological phenomena of higher organisms are the resultants of the activities of the cells, it behooves us to study the psychology of the unicellular animals. We are wont to think of several cells as needful for a psychic process in man, but here we see all the psychic processes taking place without nerves and ganglia, as responses of protoplasm to the direct action of the environment. Perhaps it would be more proper to say that the protoplasm reacts, where it is useful or needful for it to do so, in *intelligent response* to the conditions of the environment. The environment is always acting upon the cell whether there is a response or not. Protozoa exhibit exquisite sensibility without sensory organs. Pigment spots (*chromatophores*) and lenticular bodies are usually present in forms that manufacture starch from carbon dioxide by means of the energy of the sun's light, so that these "eyes" appear to be nutritive rather than sensory organs, though possibly both. The maximum amount of absorption of the sun's energy corresponds with the bands of the spectrum complementary of the colors of the protoplasm, and at the same time the maximum amount of oxygen is excreted, as proved by the bacterial test. Besides touch, there must be smell or taste for great delicacy of choice of food is often experienced as in those forms that prey on a single species of plant or animal. Some of these (*Didinium nasulum*) throw darts ("trichocytes") at their victims at a distance to paralyze them. Preudopodia and cilia are organs of motion. Some of the latter are automatic and others are under the control of the will. In sexual reproduction or conjugation there is exhibited a certain choice of certain individuals for each other. Then follows a series of evolutions or dancings about that may last for days; there is apparent a conflict between two impulses, one seeking union, the other a desire to escape; yet finally conjugation ensues. The spermatozoa and ova of higher animals are unicellular and unite under similar laws. The gen-

erative products are mutually attracted by the same impulses that bring the adults (gametaphores) together. It has indeed been shown by Pfeffer that malic acid has an attraction for spermatozoa; malic acid is present in the neck cells of *Antheridia*, but this fails to explain the mutual attraction of the pronuclei in the egg. A spermatozoon will overcome considerable obstacles, or pass by round-about paths, to reach an egg. Weber's law has been found applicable to the sensibility of spermatozoa. The threshold is a solution containing $\frac{1}{1000}$ of malic acid. If spermatozoa are placed in a solution of this or a higher strength they require a solution thirty times as strong to attract them; this ratio is constant. In the case of the spermatizooids of mosses the constant ratio is fifty for cane sugar.

If we now reflect on these facts, together with facts presented earlier, with regard to the rôle of the nucleus, the following conclusions appear safely deducible. The seat of consciousness, or at least of mind, is in the nuclear plasm, i. e. *the gemmules (chromatin granules) are endowed with psychic powers, and because of this they properly constitute the idioplasm.* We cannot leave the subject at this point, for we have premises from which very important conclusions may be drawn, and here the importance of the difference between the Kölliker and Weismann theories appears in its real light. According to one view there must be a very perfect localization of idioplasmic functions throughout the body, and this favors the localization of mental functions of a more advanced sort in the central nervous system. While according to the other view we have one part of the body as much the seat of the mind (or soul) as the other, while the apparent localization which we find is of a more extraneous nature and due to the position occupied by the cells. The gemmules of the eye and liver cells could be interchanged without interfering in the least with the functions of their organs and similarly for any ganglion cell in the center of apperception. In society this would be illustrated by taking the rail-splitter and placing him in the presidential chair, and the ex-president retiring to his farm. To Kölliker the soul of the state is the sum of the common consciousness of its citizens; according to the other theory it is the consciousness of the chief person in the realm. Every one realizes the fact that mental traits are as hereditary as physical ones; but that the learning acquired by the father is not congenital with children is simply because the reproductive cells were not concerned in the matter, but only certain brain cells. It is a special case of the non-inheritance of acquired characters. The mental acquisitions of the youth are retained by the man even though the cells concerned have multiplied in the meantime. This illustrates the law that whatever is acquired by cells is passed continuously on to their descendants. This law holds with the protozoa, *and with the germinal cells as well.* The conclusion to be drawn is that whatever is hereditary must have been the experience of the reproductive cells. If we could learn the nature of this germinal education we should be enabled to educate the unborn generations through our germinal cells. The Principles of Pedagogy have their roots in the study of the Biology of the Protozoa.

What is really done by the cells in a psychic process? Certainly a set of acts more special (*i. e.*, not of so great a range of variable work) but of the same nature as that performed by the protozoa. All is reduced to stimulus and reaction, and the same process may take place with or without consciousness. The enquiry then becomes: Where is the seat of consciousness and what physiological processes condition conscious states? Is the egg conscious? All that appears in the body was in the egg. Are the reproductive cells, are the protozoa conscious? Probably one as much as the other. These metaphysical questions are biological

questions at bottom, and do not seem to be incapable of solution with a little careful thought and experimentation. The solution of all questions of this nature can come only when the various lines of biological research indicated in this paper are completed.

Origin of the Fittest. COPE.

In this connection the final chapters of this work offer many suggestive ideas. The earlier part of the work calls attention to the important phenomenon termed "acceleration," by which is meant that every time an ontogeny is repeated the characters appear at earlier and earlier periods, or in other words the developmental history is compressed to give room for the later added acquirements.

Begriff und Sitz der Seele. SCHMIDT. Heidelberg, 1887.

What is the seat of the soul? Is it a point or in a special portion of the body? If so, where? Or is it diffused wherever there is idioplasm? We first consult Schmidt. There are three forms of biological force, contends Schmidt, more and more unified, or active at a point, as we ascend the scale, viz., unconscious mind in the plant, consciousness in the animal, and self-consciousness in man. If the soul is the life of the body there must be a central point of life, and this he finds to be the *Nœud vital* of Flourens, because a destruction of the gray matter at the point of the *calamus* causes instant death. Here is the center to which cell sensations are carried, and from which all mandates of will are sent forth. He even indicates the paths by reference to Fick's "Phantom Brain!" Organisms begin in a mathematical point; the embryo is not formed from all the cells of the morula, but from a central point corresponding with the central point of the *germinal vesicle*. In the adult the *Nœud vital* is the center of the body, (the head representing concentrated segments). It is scarcely necessary to comment upon this theory. The author is not well enough versed in anatomy, embryology or physiology to know that not any of his statements are significant, and most are sadly erroneous. Death from the destruction of the structures in the *Nœud vital* ensues because the heart and breathing movements are innervated from these points. There is no proof whatever that consciousness resides here.

Von dem Materielen der Seele. HITZIG, 1886.

This is a popular address calling attention to such facts as the increased circulation in the brain during mental work, the effect of drugs on conscious states, the effects of the removal of parts of the surfaces of the hemispheres, etc., to show that there is a material substratum for mind. The difference between man and animals lies in the power of the former to reason abstractly, while the latter depend on direct sensations. This difference is probably due to a difference of organization of the brain. If we are evolutionists we can look hopefully to the future, when the soul shall have made as great an advance beyond its present position as now it stands above the animal stage, then it may be able to understand itself.

Das Körperliche Gefühl. KRÖNER, pp. 220, Breslau, 1887.

This is a treatise on the development of the soul, and is based on biological laws. The mental protoplasm, out of which all mental powers have been evolved, is general bodily sensation or feeling. This includes simply the sensations of pleasure or of displeasure. Soul is declared to be wherever sensation intervenes between the stimulus and the reaction. A first group of bodily sensations are those not localizable, such as weariness, sleepiness, hunger, thirst, appetites, modesty, etc., all dependent upon general states of nutrition. This class of com-

mon sensations *(Gemeingefühle)* are first in ontogenetic and phylogenetic development. In the child the sensations received through the special senses are probably transformed into *Gemeingefühle*. The effects of various states of the bodily organs on the feelings of this class is next taken up in order, after which the same effects from stimuli of the special senses. To take an illustration, the flesh of animals is out of flavor during the breeding season. This is due to the absorption of odors. The effects of certain odors may spread very rapidly through the body; this is due, he thinks, to the chemical action of the substances upon the cells. An objection seems possible here that in some cases this effect is so instantaneous as to bar out all idea of the circulation spreading the substance. The effect can be due to nervous radiation only. The effect of odors may be quite soothing or the reverse. The great rôle of sexual odors in arousing passion is referred to.

In the chapter on the Emotions, the result of associations formed by coincidence of certain states and certain objects, it is shown that they may be quite individual, an object inspiring feelings of disgust with one person and of pleasure with another. The effect of ideas in producing bodily changes is dwelt upon. Emotions can't be kept up, the higher the pitch the shorter their life. Temperaments depend on the nature of the *ease* of emotional change, and on the *strength* and the pitch of the resultant feeling. The sanguine temperament is quickly moved to a high pitch, but with little strength in the emotional states. The phlegmatic is slow, low and weak; the choleric, quick, high and strong; the melancholic, slow, high, or low and strong. Even animals have temperament. Common sensations depend on chemical or nutritional changes. Irradiation of pain is due he thinks to the formation of poisonous substances at the spot of injury that spread by osmosis. The cause of sickness when viewing the sun is due to the production of products of disorganization in the over-stimulated cells. This must be taken for a rash conclusion, for reasons similar to those advanced when speaking of odors above. Once the author had occasion to use some dog grease, and no sooner had his dog come near than he was seized with a paroxysm of fear, perhaps says Kröner the dog whose fat was smelled had died in agony, and the chemical products of fear were absorbed by the fat. The effect of smells is often such as to cause the recall of forgotten scenes. Panics may be caused by a sort of odorous contagion. Here we may ask why is it necessary to have a material substance, that is conceived to act by chemical methods. In physics electric vibrations produce inductive effects, and shall we rule out the possibility of similar effects between living bodies. In acoustics we have sympathetic vibrations. A panic is a case of sympathetic action. This view if true will give the basis for an explanation of those cases of thought-transference not otherwise explainable. But thought-transference is a term not applicable, but rather emotional transference or sympathetic response. The case of the mother who after a severe fright nursed her babe and it soon died of convulsions, and all similar well-known cases are of course to be explained on the chemical theory. The effect of the emotions on the secretions of other glands, as tears, sweats, etc., is well known; sad news destroys the appetite. When stimuli are repeated they do not affect protoplasm as did the first one, this is not due to a general weariness of the nerve, for if a different sort of stimuli is used we get a greater effect. This is due to a sort of adaptation, similar to that which takes place in opium usage and other habits where the dose must be constantly strengthened to produce its effects. Tickling offers some curious features that are not easily explainable. Only the *Culturmensch* can be tickled (?) It is a species of shuddering. Pain may be defined as an unusual stimulus, one which the cells have not learned to interpret or meet with proper reaction.

But there are also special paths for pain that give ideas of injurious effects that the body as a whole can control. Natural selection has evolved ideas and memory in those lines only where such psychic activities are useful. For the body in general it has been found sufficient to retain the common sensation of protoplasm.

Change of Life. TILT.

Tilt advocates the view that the visceral ganglia are the seat of the emotions and brings much matter of observation of disturbance of these ganglia by the involution of the ovaries. The effects of "gangliapathy" are such as to profoundly disturb the body and cause even insanity. A blow at the pit of the stomach may kill as quickly as a puncture of the *nœud vital*. Note the disturbance of sea-sickness, the vomiting of pregnancy, nightmare and of *globus hystericus*, which latter begins by a sensation rising from the pit of the stomach. This may be caused by continued pressure on the ovaries, and end in convulsions. Hysteria is the "keystone of mental pathology," and if he were lecturing on insanity he would begin with an accurate study of a complete case of hysteria and show the regular steps by which it may culminate in mania and other forms of insanity. "The epileptic aura radiates from the ovaries. Between haziness of intellect and idiocy there are all gradations, between a girl's temper and mania there is no break, and fidgets may pass through hysteria into convulsions. We must go back to Hippocrates who thought the abdominal viscera caused insanity. There is no passion without ganglionic or visceral sensation." These are pregnant words but in extending the realm of the soul from the central nervous system to all nerves, why draw the line here? Nerve cells are part of the same protoplasm, have a common germinal ancestor with all other cells. The fundamental properties of cells are alike. If a cartilage cell does not play so important a part in the psychic activities of the body as a ganglion cell, neither is it situated favorably for such a purpose,—it is not connected by a nerve to an end-organ. Even in the nervous system itself it becomes necessary to distinguish parts that act outside of consciousness. The intellect is indeed produced through the experiences of a special portion of the central nervous system, but this is only one organ of the soul. The greatest philosophers have seen the necessity for extending the realm of the soul. Leibnitz for instance considers every atom to be souled. What idea is denoted by this term soul? The word stands for a philosophic necessity rather than for a definite idea. The problems of science are always pushed back to a threshold where something different from matter must be postulated, something that does not suffer from the limitations of three dimensional space, the law of the conservation of energy and other ideas inseparable from the sensible universe. With reference to such a realm thought must work without images, as for example is the case in the consideration of *non-Euclidian geometry* (geometry of more than three dimensions). From such a standpoint it becomes rational to say that all the hereditary characters are conserved in the egg, though only a few are actually manifested in its structure at any one period of development, and again, that each gemmule contains all the characters of the complete being of which it is a part, often only a transitory part.

The Soul, or Rational Psychology. SWEDENBORG, pp. 388. New York, 1887. Translated by Frank Sewall from Dr. Tafel's Latin edition, Tübingen, 1849, from posthumous MS. Upsala, 1742. (Part VII of "The Animal Kingdom.")

The preceding leads us logically to consider the last work on this list for review, which though only relatively modern, is chosen for its rep-

resentative character. It is probably the ablest exposition from a transcendental standpoint we have. The author is not in repute among scientists of to-day for obvious reasons. He is purely a speculator, and still worse, in his later life became subject to hallucinations that were incorporated as the keystone to his system, and which like the Comtean system became the creed of a religious sect.

This "Aristotle of the North" informs us that the great purpose in all his studies has been the discovery of the soul. "There is no other field of exploration than that of the anatomy of the organic body." This was before the time of cell theories, embryology and physiological experiment. In his dissections, Swedenborg found the fibre (muscle, nerve, arterial, etc.,) making up most of the body. The fibre is considered the unit of structure, but the fibres of the brain end in "glandules" (ganglion cells, undoubtedly). All fibres are conceived as hollow, and as carrying a blood. There are three degrees of fibres. The tunic of the blood vessel is composed of fibres of the same grade of organization as the constituents of a nerve. The tunic of the nerve fibre is composed of an organization of "simple fibres," (nearly corresponding to our idea of *fibrillae*.) The last carry the "supereminent blood" (nerve force), and are themselves composed of molecular constituents called "pure intellectories," which are "vortical forms" (cf. "vortex rings" of our physicists) and are the soul in its first spatial manifestation. These are incapable of dissolution, are not affected even by fire, and hence not subject to death, which last is only a dissolution of the coarser grades of organization down to these monads. In each is a special determination of the soul so harmoniously interrelated as to constitute the "form" of the individual or species, from which the spatial relations of the parts of the body become derived during devel opment. When death dissipates the monads in three dimensional space, heir relations in the soul-form are undisturbed. The organic relations f the intellectories is the "pure intellect," present as the life (or heredtary nature) of all biologic beings; it constitutes the celestial body of the soul, and unless a coarser body is formed, the soul remains out of relation to the environment of the world. This coarser body constitutes apparently what we know as protoplasm. It can receive impressions from nature only by means of different forms of vibrations. Each form of vibration is received by the cells as such, and is transformed into sensation in which the relations or qualities of the different forms of the vibrations are preserved, and hence the specific energy of nerves. The constituent units of a derived organization are termed the "internal;" the derived unit the "external." The internal of one form is itself at the same time the external of its units. The units are always each the complete image ("effigy") of the derived or greater unit. Each brain cell is a brain in a less form, and its units the "brain in a least form." Now, when a change is produced in the external, the "harmony" of the external and internal causes a correspondent change in the internal. But if we could see the changes it would be impossible to compare the two sets, they differ so radically in their nature. This is the celebrated "doctrine of correspondences," by which Swedenborg sought to explain all things celestial and terrestrial. There is therefore no commensuration between a physical vibration and a change of consciousness which arises coincidently; and hence there is no psychic localization in the brain. Every stimulus received, radiates to all parts; but by the laws of corresponding harmonies the qualities and relations of the external stimulus, as for instance the different parts of a retinal image, affect the monads with the relations completely preserved. For in the soul is a "pre-established harmony" corresponding to all possible modifications that may arise. These harmonies are affected (like sympathetic vibrations) in this manner, viz., the harmony or relation of the vibrations

causes sensations. The relations of the sensations affect the next "internal" and cause the "affection" termed perception (images). The relation of images affects corresponding harmonies in the "pure intellect," and these changes are *thoughts*. What is the difference between the human and the animal soul? Here, as elsewhere, Swedenborg is obscure and extremely difficult to comprehend. We feel sure that he is logical and has definite ideas on the subject, even if we see as "through a glass darkly."

The life of the sensations constitutes the animal soul or "animus," also called the "inferior mind." In the animal this is completely dominated by the "superior mind," (pure intellect) and has no independence of its own. In man there is interpolated between the two, a "rational mind," which exists at first as a power of attention or free will. This is the "man proper" as to his self-consciousness. He can turn either to the sensations or to the superior mind and establish the relations existing in the animal by allowing the superior mind to control the animus. But failing in this, the animus asserts its control, and being blind like Schopenhauer's Will, works destruction. This is the Fall of Man. This rational mind becomes organized in time (ontogeny) out of the experiences of life. Every cell is both sensory and motor, both receiving and giving stimuli. Each cell has its own will, and hence wills must be distinguished into genera and species. Will is simply the effort to break forth into act, and action ensues when the tension overcomes the obstacles on the reception of appropriate stimuli.

This is a meagre outline of salient points of a system that goes into complete details of all phenomena, and seems to compare favorably with the systems of other great philosophers; it is remarkable that all notice of Swedenborg is wanting in histories of philosophy. Besides this the man himself, with his thirty years' record of orderly daily hallucinations offers a wonderful problem to the student of psychology. This work closes the pre-hallucinatory portion of Swedenborg's literary career, and one cannot help thinking that had he died then, his fame would have been greater. Now, nobody thinks of him except as the "seer," or "madman." The following words from the Rational Psychology, sound quite sane. "When we live as souls perhaps we ourselves shall laugh at what we have guessed at in so childish a manner."

If this review shall suggest a closer sympathy between Biologists and Psychologists in the effort to solve the problems of life, it will have accomplished its mission.

III.—CRIMINOLOGICAL.

By Arthur MacDonald, Ph. D.

Criminal anthropology is one of the most recent sciences. In 1885, the "First International Congress" was held at Rome. The second congress met at Paris last August. At first the scientific study of criminology was looked upon with suspicion. At present, interest in the subject is greatly increasing. Like every new science, it is in its polemical stage. The Italians are the innovators. The criminologists are divided into two parties: one emphasizes the pathological or atavistic causes; the other, the psychological and sociological. The latter are subdivided into socialists, who would account for everything by the inequality of economic conditions; and those who take into consideration all social phenomena. The literature is almost wholly new.

The divisions of Criminal Anthropology and its relations to other sciences might be indicated as follows:

Criminal *Embryology* would consider the equivalents of crime in the vegetable and animal kingdoms. The *Anatomy* of Criminology includes

more especially the Craniology, Brainology, Histology, Anthropometry and Physiognomy of the criminal. In Criminal *Psychology* one would study the entire psychical life: Intelligence, Sentiments, Sensibility, Ethics, Æsthetics and Religion. Criminal *Sociology* comprehends the association of criminals; their relation to the state; economically, and in connection with poverty and misery. Criminal *Jurisprudence* takes into consideration all criminal laws, and their underlying principles. *Penology* treats of the principles, degrees and methods of punishment. *Statistical* Criminology has for its object, the arrangement, classification and summary of all criminal data; and their interpretation. Criminal *Hypnology* concerns those hypnotic and partially hypnotic conditions, in which crime is committed; especially in the case of hysterical individuals. Criminal *Epidemiology* considers those conditions, where through imitation, or by a sort of contagion, crime suddenly develops. Criminal *Teratology* treats of Pathological Sexuality, Onanism, Pederasty, Sodomy and Saphism. Criminal *Prophilaxy* considers the methods of prevention; through alterations of social condition, physical, intellectual, moral and religious education; by means of prisons, transportation and deportation. The *Philosophy* of Criminology takes up the more disputed questions and theories: as Atavism, Infantilism (natural depravity of children,) Degeneracy, the interpretation of psychical and physical characteristics, and crimino-psychiatrical cases. We may add, that the whole study of pathological humanity may do for humanity what pathology has done for medicine.

Les criminels, charactères physiques et psychologiques, par DR. A. CORRE. Paris, 1889; pp. 412.

The real criminal is he who does not recognize the rights of others; he is not a simple offender, but a hypocritical one; not like the man who opposes society openly. Every great man who establishes the supremacy of his country, and under the pretext of maintaining it, in the name of public safety, commits the most detestable acts solely for his own interests and caprice—such a one is a criminal. However, admit two groups, those who are imprisoned for their misdeeds, and those who are free. Does this opposition correspond to the particular aptitudes in the groups which present it? Does criminality lie in the individual or environment? If in the environment, in what measure can it be modified? The answers to these questions are based upon anthropological and statistical documents.

In regard to the brain, the author does not find anything strictly peculiar to criminals. In respect to the cranium, the following points are noted: 1, the more frequent persistence of the metopic or frontal median suture; 2, the effacement, more or less complete, of the parietal or parieto-occipital sutures in a large number of criminals; 3, the notched sutures are the most simple; 4, the frequency of the Wormian bones in the regions of the median posterior fontanelle, and in the lateral posterior fontanelles; 5, the development of the superciliary ridges with the defacement, or even frequent depression, of the intermediary protuberance, the development of the mastoid apophyses; 6, the backward direction of the plane of occipital depression. General sensibility is lower in criminals; left-handedness is common; imperfection of sensitive activity; this lack of sensibility to pain and to disagreeable sentiments explains the want of pity and the cruelty of criminals. The true criminal has something of the incompleteness of the beast; he is a man who has remained animalized; he is an opponent of altruism, is lazy, likes wine, gambling and debauch; in general he is afraid of the thought of death, indifferent to religion; without remorse; he is extremely vain. Intelligence does not develop his altruistic feelings; although very cunning, the criminal is inferior in intelligence.

There are criminals of genius; some are honored by the world. They are egotistical monsters; if possessed with power, they commit crimes under other names; the slang of the criminal is rich in words for drunkenness, wine and money; educated men among criminals are rare. In the majority the notion of the act is so persistent as in a certain measure to take away legal responsibility. In many impulsiveness is sudden and irresistible; onanism and sodomy are common. Recidivists are increasing in number. The physiognomic characteristics are in general: small cranial dimensions, receding forehead, absence of beard, abundance of hair and dull eye, (women criminals are almost always homely); thick lips, projecting eyes and large jaws. These characteristics, while common, are by no means absolute. An individual always considered of sound mind, who does things, the motive of which is inexplicable or out of proportion to his appetites, is to be regarded rather as insane than criminal. In delicate and disputed cases those with most experience and intelligence should decide, and not the jury. Among the cases of doubtful criminality are giddy, epileptic, hysterical women with hereditary taint, who, commencing with eccentricities, go into crime. The legislative idea of premeditation is to be replaced by that of the degree of intensity or duration of the solicitation. Criminals from sudden passion are more excusable than those who commit crime under the influence of drunkenness by alcohol, ether, morphine or hashish; for the latter, although far less conscious of their deeds, know that these drugs expose them to such acts. The highest grade of criminals are so by profession, who are knowingly and deliberately rebellious against society. The last class are the false-honest men, who, by the cloak of wealth, power, position or honor, utilize society solely for their own disordered appetites.

Rejecting the criminal type in the sense of anthropological unification, the author believes that the cerebral inferiority of the criminal has its origin in a sort of arrest of development in childhood. Admitting a subordination to the acts of the organization, and the want of liberty society should not punish the less, as it is her only way to maintain herself; but should keep within the strict limits of self-defence. The death penalty is a relic of barbarism; the ideal is not repression, pain for pain. A wise code should reprimand by bettering, not by destroying; it should diminish the intensity of the solicitations to crime; it should remember that society is in a great measure the cause of criminality. The author, while stating his own views without reserve, shows a broad spirit towards the views of others; on the whole he is not extreme, but takes a medium course. The first part of his book, which treats of the physical organization, we regard as the most valuable.

L'Homme criminel, étude anthropologique et médico-légale par CESARE LOMBROSO, traduit sur la IVe édition italienne, avec préface par M. Letourneau. Paris, 1887. pp. 682.

The first motive in our savage ancestors was the necessity of self-defense, reflex action, blow for blow. In plants we find the equivalents of crime, in the case of certain species which entrap and kill insects. In animals acts are more similar to those of man, are more mechanical, having slight traces in consciousness. In men continual aggressions gave rise to balancing wrongs, and vengeance appeared, giving the law of primitive justice, retaliation, which became a duty. But as some of the particulars of this law were overlooked, the legal power became a sort of revindication; the punishments were of the most cruel nature. To-day there is a vague feeling, an echo of ancient retaliation in our punishments. If punishment rests on free will, the worst men, the criminals by nature, should have a very light punishment or none. Penal repression should be based on social utility scientifically

demonstrated; instead of studying law texts, we need to study the criminal. The criminal by nature has a feeble cranial capacity, a heavy and developed jaw, a large orbital capacity, projecting superciliary ridges, an abnormal and asymmetrical cranium, a scanty beard or none, but abundant hair, projecting ears, frequently a crooked or flat nose. Criminals are subject to Daltonism; lefthandedness is common; their muscular force is feeble. Alcoholic and epileptical degeneration exists in a large number. Histologically, their nerve-centers are frequently pigmented. They blush with difficulty. Their moral degeneration corresponds with their physical, their criminal tendencies are manifested in infancy by onanism, cruelty, inclination to steal, excessive vanity, impulsive character. The criminal by nature is lazy, debauched, cowardly, not susceptible to remorse, without foresight; fond of tattooing; his hand-writing is peculiar, signature complicated and adorned with flourishes; his slang is widely diffused, abbreviated and full of archaisms. In their associations they return to primitive social forms. The general cause of the persistence of an inferior race-type is atavistic. As the born criminal is without remedy he must be continually confined, and allowed no provisional liberty or mercy; the ancient tradition of vigorous initiatives should be upheld; the more we diminish individual responsibility, the more we increase that of society, which is still more severe. Nature is responsible for the born criminal, society (in a great measure) for the criminal by occasion.

The work is full of facts, it shows the sincerity and patience of the author, who is an expert experimenter, and a person of philosophical acuteness. He has given an extensive description of the born criminal considered physically, morally and intellectually. The author seems to us to go too far in holding to the incorrigibility of the born criminal, and in not allowing him provisional liberty; the incurability of the recidivist is pushed too far, for neither of these positions are supported by a sufficient number of scientific facts.

La Criminologie, étude sur la nature du crime et la théorie de la pénalité, par R. GAROFALO, agrégé de l'université de Naples. Paris. 1888. pp. 420.

The science of pœnology must not rest on the idea of freedom, which is in contradiction with scientific facts; on the idea of freedom the hardest criminal should go free as he has least control over his acts. The pœnological criterion is social necessity, abandoning the idea of moral responsibility of the individual. The present system has neither cured, nor terrified the prisoner; after his sentence is served, he is as dangerous as ever. The laws should be changed so as to be in accordance with criminological facts. Crime is a harmful action, that injures at the same time the moral sense of aggregate humanity. Murder, parricide, infanticide, robbery have not always been crimes; but the analysis of the sentiments and not of actions is the basis for a criterion. The race possesses innate moral instincts as it does a physical type; when the moral sense becomes psychical, it is subject to alterations, diseases, can be lost or wanting, a parallel to any other organic monstrosity. The moral sense of aggregate humanity consists only in the altruistic sentiments which can be reduced to benevolence and justice. A crime is the violation of the elementary altruistic sentiments of pity and probity. In Europe the relative increase of crime has advanced with civilization which shows that the present methods are almost a failure. Punishments have become less severe; moral responsibility is more considered and capital punishment is rare.

A criminal type is as well established as an Italian type; not a single characteristic constantly distinguishes this type, but the proportion of congenital anomalies is larger in any given number of criminals than in

an equal number of non-criminals. Recidivation of the criminal is the rule, reformation the exception. The absence of elementary moral instincts is not an infirmity; instinctive criminals are not sick nor insane; perversity is natural. The criminal is a being at present unadapted to surrounding circumstances; he is a monster, and presents the traits of past racial regression. All criminals are born, but predisposition does not exclude the influence of surroundings. One class of criminals are those with regressive, arrested moral development, innate criminals; for these society has but one remedy: elimination. Another class are those somewhat deficient in the feeling of pity; and a third class lack the sentiment of probity. Atavistic perversity exists in spite of the best surroundings; the influence of intellectual instruction is almost null. In Spain, where two thirds of the population are illiterate, criminals are few. Religious instruction, if begun early, and if its purpose is moral teaching, has good influence, except in the graver cases. Crimes due to cupidity will not cease by bettering the social conditions. Economic conditions may change the form of crime, but they are not a cause of crime in general. In the first half of this century a high degree of criminality was greatly reduced, in the second half (1828–84) crime has increased enormously and punishment has been made milder, the increase of recidivists is greater than that of all criminality; this points to a concentration which should render its prevention easier. Murder severely injures the moral sense of the community, a reaction in the form of desire of exclusion from society is produced, through lack of adaptation. The only absolute means of exclusion is death, but this applies only to the criminal by nature. It is the duty of society to eliminate those who are utterly unadapted to society. Punishment is not to punish the criminal, but to eliminate him absolutely or partially. The death penalty has given England the fewest criminals of all Europe. The common ideas, that there is no crime without moral responsibility, and that punishment should be in proportion to the gravity of the crime, are incompatible with scientific facts. It should be first determined to what class of criminals the culprit belongs; a man, who hires an assassin to kill the individual who outraged his family, is quite a different criminal from the assassin. The cause of a murder, and the absence of any grave injury on the part of the victim are the criterions to be substituted for premeditation. The worst criminals commit murder without premeditation; but in the case of the criminals by occasion, premeditation indicates a cruel nature, and elimination may be necessary; for the other classes of criminals, deportation, fine, removal to another environment, agricultural colonies, work for the state, etc. etc. The controlling ideas of the author are social utility, and the natural reaction against crime.

The author's extensive experience as a magistrate gives peculiar interest to his views on the pœnological side of criminality. He seems to us to draw too sharp a line between abnormality and disease. The born criminal is wholly teratological, a moral monster; but a teratological characteristic may arise from a deviation in utero—a real disease of the egg. His insistence on the absolute elimination of the born criminal is extreme; first, because it assumes the criminal's utter want of adaptation to society, which is not warranted by a sufficient number of facts; second, admitting his want of adaption, we fail to see why a society in which the public conscience is highly sensitive, might not substitute perpetual detention; for it is a question of social utility, whether the hardening of the public conscience is not morally injurious.

Concetto e limiti della sociologia criminale. CALAJANNI NAPOLEONI. Rivista di filosofia scientifica. Novembre, 1888.

The writer is the standard-bearer and the principal authority among Italian socialists. In human society development is not always normal;

it as a whole suffers from disease, just as the individual organisms; hence the necessity of the study of the morbid or abnormal state—a pathological sociology. This comprehends the study of the anomalies opposed to nature, showing their co-existence and their derivation one from the other in the social organism. Criminal sociology occupies itself with the criminal manifestations. Romagnosi, the statesman, says, that crimes are the diseases of the social body; sometimes they are general, sometimes local, now permanent, now transitory. Criminal sociology reaffirms the analogies between biology and sociology. The difference in the laws and respective characteristics is shown, not only in the fully developed organism, but in assigning to sociology the principal characters of the evolution in all the phases of one society. The utility of social criminology is direct and indirect: (1) By the study of the pathological alterations, the knowledge of the normal functions is increased; thus one is better able to determine the relation between cause and effect in diverse social phenomena; for as Drill says, delinquency is a sensible measure of the degree of health, strength, and prosperity of a given society in every given moment of its existence. (2) The direct utility of the study of social pathology, especially of criminal sociology, is intuitive; it directs one towards the care and prevention of crime; in lessening pain by gaining a just and free exercise of law, which results in the diminution of crime. But what is the place of criminal sociology in the hierarchy of the sciences? Lucchini, Fulci and Puglia, three famous Italian statesmen, maintain the superiority of the law to that of sociology. Others hold that legal science is only a chapter in sociology.

Now, sociology is a study of the whole life of the social organism. Liszt would divide biology into anthropology and criminal psychology. Moleschott thinks that sociology should be included in anthropology. But anthropology should be an introduction to sociology. Garrandi's division is: (1) Study of the world of criminality in its actual state and in its history; (2) Investigation of causes which produce crime; (3) Indication and organization of the means of combating crime. But a more practical division is this: (1) Genesis and etiology of crime; (2) Treatment of crime, (a) prevention, (b) repression; (3) history and course of crime.

Dégénérescence et criminalité, essai physiologique, par Ch. Féré. Félix Alcan, Editeur. Paris. 1888.

This book contains short chapters treating the subject generally, and is critical of the results of those (Lombroso, Garofalo, and others,) who are more specialists in criminology. In addition to the general interest of the book, it may be useful in guarding one against the exaggerated inferences that specialists sometimes make in connection with the facts they present. The author introduces some physiological conditions of the emotions. The physiological conditions of crime are more frequent with the feeble. The author considers the atavistic origin of crime as a pure hypothesis. Anatomical and physiological characteristics are not sufficient to establish anything; cerebral anomalies point merely to the fact of complexity and irregularity in brain morphology in general; there is no criterion of criminality except the material proof of the crime. Whatever one thinks as to the moral responsibility, there is no doubt as to legal responsibility, the main object of which is to preserve society; that is, to treat dangerous criminals as dangerous sick persons. Society is responsible for the conditions which breed criminals. Education and instruction work with a limited number, who are not prone to evil through an organic defect, and with whom it is possible to develop general utilitarian motives; the principal cause of misery lies in organic inferiority.

Some etiological conditions of criminality are: abuse of alcohol,

and example; thus, as to the latter, the idea of an act is already the act which commences; thus the publicity and minute descriptions of criminal acts develop similar tendencies. The only curative process which experience seems to favor is assistance, by which is meant, to help the criminal, in his struggle for existence, to gain an equilibrium between his needs and his power of production. The analogies between the practical treatment of the insane and the criminal may indicate a natural method towards the solution of the question.

Zwei Kriminalpsychologische Fälle. Ein Beitrag zur Kenntniss der Uebergangszustände zwischen Verbrechen und Irrsinn, von Dr. AUG. FOREL. Professor der Psychiatrie in Zürich. Bern, 1889.

In spite of opposition, determinism, based upon evolutionism, is becoming more prominent in contemporary philosophy. Contradictions between legal ideas and legal punishment will vanish so soon as punishment is for the correction of the prisoner and the protection of society, and not an expiation of the deed.

Those persons known to have a lawless disposition should be taken care of before they can do injury to society, and, on the other hand, inmates of prisons, should be psychologically studied, as to when and whether they should be given freedom, instead of holding them a certain length of time, according to the nature of the deed. The time is to come when the treatment of criminals will belong in part to psychiatry and in part to psychology. A normal psychical state is an adequate adaptation of the mind to the forces in the outer world. A normal free will is nothing else than an adequate reaction of the mind. A criminal act is an inadequate reaction. The writer cites two cases, giving the details at some length; one exhibits a high degree of weak mindedness, with an inborn ethical defect, weak judgment, liable to repeat similar acts. In this case the person was found guilty of kidnapping a child, and sentenced to ten months in the work-house. The second case is that of a person shooting his friend without warning, and then shooting himself; a case of hereditary insanity, of deep ethical defect, contrary sexual feeling, hysterical fanaticism, etc. There are all kinds of transitions marked by constitutional and chronic disturbances of the mental equilibrium, the disease can appear as almost natural to the organism, merely as an individual peculiarity, an inadequateness. Thus there are no sharp limits between the inadequate character of a criminal and that of a normal man, just as there are none between bodily anomalies and health in general. Moral training, safeguards and principles are the best means for forming a habit of life that will endure.

Reflections on the Theories of Criminality. Rev. W. D. MORRISON. Journal of Mental Science, April, 1889.

It is by careful study of individual criminals, as has been wisely said, that advance in real knowledge of criminal psychology is to be made. Mr. Morrison's paper is one of this desirable sort. A laborer turned out of his lodgings with his family, somewhat the worse for liquor (though not actually intoxicated) and passionately excited, takes revenge by dashing out the brains of his two-year-old son. The author summarizes his personal and family history, his anthropological characteristics (including craniometric measurements) his mental condition, (senses, intellect, emotions and will), and the active and potential causes of the crime. He concludes that the murder was "the result of adverse social circumstances acting on a criminally-constituted organism. . . . The circumstances alone or the organism alone would not have sufficed to produce the deed."

Le crime et l'épilepsie. G. TARDE. Rev. phil. Nov., 1889.

M. Tarde subjects the views of Lombroso on the epileptic affiliations of crime, as brought out in the second volume of his *L'Uomo delinquente*, to a thoroughgoing examination and finds them far from demonstrated. But if Lombroso has failed in establishing his thesis, his error was not in supposing a common bond in all kinds of crime, but in naming it. Epilepsy is only the extreme type of a periodicity which marks all psychic action and which may be observed in the most normal. A psychic state once experienced tends to repeat itself periodically, and most of all criminal states, for they are, at first at least, most striking and impressive because out of the usual order. But periodicity, because it is universal, cannot stand as a test of responsibility; it is those whose periodicity carries them through psychic extremes, whose orbit is cometary, that are the irresponsibles. Tarde himself gives an important place to the social principle of imitation. It is self-imitation (habit) and imitation of others, that makes criminals recidivists, and carries honest men along the lines of uprightness.

Die Psychologie des Verbrechens; ein Beitrag zur Erfahrungsseelenkunde, von Dr. A. KRAUSS. Tübingen, 1884. pp. 421.

The author gives the results of a long and active study on the phenomena and conditions of crime. The standpoint is that of empirical psychology. Physiology is touched upon only so far as is necessary to the understanding of the question at hand. The author does not think that the time has arrived to unite these two sciences; their separation must be considered as yet a scientific miscarriage. The causal connection of criminal phenomena is sought out and traced back to a common ethical principle. The following are some of the main points: Self-consciousness is the source of morality and immorality; of morality, so long as it postulates the clear knowledge of the moral law; of immorality, so long as it leads to self-exemption, and the emancipated "ego" becomes itself law. The degrees of moral consciousness are the criterion of guilt and responsibility for every moral failure; childhood represents an unripeness; idiocy a potential incapacity of moral development. Old age postulates a weakening of the moral power of resistance, since it is accompanied with a certain dullness of self-consciousness. Conscience, the substance of moral feeling, fulfils in man that spiritual normality which makes him responsible for all his acts. This moral freedom is nullified by two organic conditions, insanity and abnormal sleep, on account of the formation of illusions. The love of pleasure and the aversion to labor are by far the greatest sources of crime. The weakening of moral consciousness increases with the number and organization of societies of criminals. An irresistible force, outside of pathological conditions, is not recognized by an earnest administration of justice. Strictness is throughout more rational than mildness. The penitentiary is perhaps the high school of crime; the only rational method is deportation, not only because society is freed from a pest, but the criminal through new conditions is better enabled to self-reformation. The death penalty is the only form of punishment for a cold-blooded and premeditated murder.

War with Crime, by the late T. BARWICK Ll. BAKER, Esq., edited by H. Philips and E. Verney. London, 1889. pp. 299.

The book consists of a selection of reprinted papers on crime and reformatories. The author was a magistrate of experience, and had much sympathy for the poor and unfortunate. He makes crime due to a form of mental disease, for which the prisoner is not the only one responsible. The disease must be combated rather than the individual. In the war with crime, prevention and not retaliation is to be carried on by cumulative punishment, that is, the penalty should be apportioned

rather by the antecedents and number of repetitions, than by the heinousness of the crime as judged by itself. There should be a steady increase in severity of convictions after a second conviction; yet the door to reformation should always be kept open; and this could be done by adding to sentence of imprisonment a term of police supervision. While enthusiastic for reformatory work, the author was opposed to reformatory schools under the exclusive control of a committee of magistrates. Reformatories should be limited to cases of confirmed criminality. In case of boys arrested by policemen, a short stay in prison (fourteen to twenty-one days) should precede the entrance into a reformatory school. In the case of vagrants a distinction should be made between the man who travels in order to live, and the man who lives in order to travel. There is no fear from over-education. The book is valuable from its practical nature. While some of the methods of reform may be outgrown or generally accepted, an account of them has historical importance in giving a practical insight into the development of reformatories.

Penological and Preventive Principles, with special reference to Europe and America. By WILLIAM TALLACK, Secretary of the Howard Association. London, 1889; pp. 414.

Notwithstanding the variety of opinion among those of long experience in the charge of criminals, there is a preponderance of experience in certain directions. It is the special design of this book to aid in recognizing these converging lines and approximate conclusions. The author is a strenuous upholder of the necessity for the effectual separation of imprisoned criminals, as opposed to the system of classification and association of criminals. The author appeals to the penal experiences of different nations: France, almost despairing in legislation, had the Récidivist Law for the extension of penal deportation; also the number of imprisonments increased threefold in half a century, from 41,000 in 1836, to 127,000 in 1888; and the "recidivists" increased from 31 to 48 per cent in the more serious offences, and from 28 to 43 per cent in the minor ones. In the United States there has been a steady increase of crime to population, and a shocking development of corruption in the county jails. In Italy we find almost the worst predatory and homicidal classes in gangs of contaminating villany among the prison population. In Germany the prisons are largely schools of crime. In Australia the system is condemned on all sides; it led to conspiracies, insubordination, vices, increase of expenses, contamination, and no possibility of reforming the criminal. In England, with its cellular local jails, and in Belgium and Holland, with similar central prisons, where separation is secured or approximated to, we find the criminals most effectively held in check. In this system there should be added a re-arrangement of sentences; that is, short, but sharp ones; more really penal, but more mercifully deterrent and reformatory. But another purpose of this book is, to show that the efficacy of prisons in the repression of crime is immensely exaggerated, in comparison with other methods of reformation. As to legislation, a reasonable cumulation of penalties is desirable. The element of certainty is very important. Judiciously administered substitutes for imprisonment, including conditional liberty or probation, fines and moderate corporal punishments, are merciful and economical alternatives for prolonged incarceration. These views are held by the majority of penologists. As to preventive influences, too little attention is given to the restorative agencies of religion and morality, (including under the latter head, the wise encouragement of temperance, chastity, thrift,) systems of education and training children to a self-supporting industry, the influence of piety, fostered mainly by denominational schools, where their faith is

kept from being needlessly assailed—all these factors are too much neglected. It is generally admitted that the prevention of offences and the development of society is forwarded by reverence for law and order, and a wise use of fear and hope, reward and penalty. Now it is pre-eminently in the Gospel that we find these principles most authoritatively embodied and exemplified.

Prison Statistics of the United States for 1888. By ROLAND P. FALKNER, PH. D. Philadelphia, 1889; pp. 34.

This brochure presents many interesting facts. There is a homogeneous convict population in our prisons. The county jails and houses of correction have a continual change in their population, owing to short sentences. The percentage of colored prisoners is much greater than that of the colored population. As to age, the prisoners are as a rule in the prime of life; the higher age classes are less represented than in the general population. The foreign element furnish a larger number than the native-born, but they stand relatively lower in the grave offences than in the less serious ones. The British-American element makes a bad showing; in Michigan, 38.14 per cent. of the foreign prison population; and in Maine, New Hampshire and Vermont combined, 60.85 per cent. of it. The Germans have the same ratio in crime as the native-born. Interstate emigration is common, so that those born in other states are represented more strongly than in the population generally. The unmarried show relatively a large percentage, especially in the western states. Manufacturing, mechanical and mining occupations show a large percentage of crime. Those having no religion are large in number. The percentage of Catholics is quite high, caused mostly by nationality and economic condition. The Hebrews show a very small percentage relatively. Crimes against person have the largest percentage in Maine, Michigan, Nevada and Alabama. Why it should be so high in Connecticut, New Jersey and Southern Indiana, is not clear. In the South there is a large percentage of crime against the person.

Sur le fonctionnement du service des signalements anthropométriques, par A. BERTILLION. Archives de l'anthropologie criminelle. 1888. pp. 19.

This is a report addressed to the director of penitentiary administration in France. The repertory of anthropometrical descriptions commenced in January, 1883 had reached the number of 60,000 in November, 1887; and has brought about the detection of about 1,500 recidivists inscribed in the jail books under false names. The author describes the manner of obtaining uniformity in results, the classification of measurements and the distinctive characters of recidivists under a false name, giving some curious examples of detection. It seems to us that this is a direct step toward the detection and subsequent control of a most difficult class of criminals.

Physical Training of Youthful Criminals, by HAMILTON D. WEY, M. D. Reprint of a paper read before the National Prison Association at Boston, July 18, 1888. pp. 14.

Physical training and athleticism are to be sharply distinguished. Physical education should precede mental; it aids the slow and irregular movements of the criminal, gradually giving him better control of himself; the mind is quickened along with such training. Bathing and dietetics are adjuncts to physical training. Physical education should be carried on in a three-fold line: physical development, muscular amplification and structural enlargement. Let the physical man be trained to reach the highest attainable degree; the brain coincidently will participate, and the mind will afford a basis for the principles of morality. The brochure is valuable in giving many practical details from the more advanced point of view of criminologists.

"*Inside Out.*" *Present Prison Systems and their Effects on Society and the Criminal*, by RICHARD VAUX. Philadelphia, 1888. pp. 31.

The writer expresses in a popular and vigorous way the following ideas: For certain crimes, as murder, arson, burglary and obstructions on railroads, in which life is lost or put in peril, the *penalty* should be death — not the *punishment*, for such crimes are beyond the limits of those violations of law for which punishment should be applied. Crime is largely the outgrowth of vicious social influences. State trade-schools with no locks, bars and bolts is a practical preventative to crime. There is a morbid humanitarianism — too much sympathy for the criminal, and too little for the friends of the victim. The state is tired of supporting individuals who ought to have been hung. The intermediate sentence, and qualified discharge before expiration of sentence, is not good; for the oversight after the discharge is not practical. However, in the case of first offenders with whom the prison authority is thoroughly acquainted, the prisoner might be released. The present system is administered by force. It should be turned inside out to discover what is bad, and to gain what is best.

The Chronicles of Crime, by CAMDEN PELHAM, Esq. London, 1886. 2 vols.

The author gives a series of memoirs and anecdotes of notorious criminals in Great Britain from earliest times to 1841. He thinks that the representation of guilt with its painful consequences is one of the best means of warning the young against the danger of temptation. To carry out this purpose, care has been taken to omit matter unfit for general reading. The earlier pages have been taken from sources peculiarly within the reach of the author. In comparing the offences with those of later date the dreadful crimes and brutal punishments are rare. The following are a few cases: execution for high treason; guilty of manslaughter, burnt in the hand; guilty of stealing a horse or cow, executed by having the beast pull out the peg that allows the ax to fall; 1921 women strangled and burned for counterfeiting; burnt alive for murder of husband; convicted of rape, not punished through influence of friends; executed for attempting to poison; executed for robbing the mails. Most of the cases are those of murder. The benefit of reading details of this nature seems doubtful in the case of the young. The less the young read about or witness cruelty, the better.

Report of the Standing Committee on Crimes and Penalties, to the National Conference of Charities and Corrections held at Louisville, Ky. 1883. pp. 15.

The report is especially valuable on account of the consensus of opinion. The general conclusion is: To make the laws such, that the criminal must either reform or be kept under restraint; to make prison structures roomy enough to allow of classification and efficient educational work; to permit conditional release; the reforming of the prisoner, and not the production of revenue should be the aim. Inefficiency of punishment is largely due to the spirit of retaliation in penal law, for this causes a counter retaliation on the part of the criminal. The professional criminal regards penalties as a business risk; the criminal by occasion forgets them at the moment of the act; the cranks are too absorbed in their wild ideas; the criminal by nature will commit crime in spite of them, because he likes to. Some existing defects are: Bad condition of station-houses and jails; Pensylvanian system of separate confinement is the only true plan; want of graduated prison system with conditional release; contract system bad; "Piece-price plan," where contractor furnishes machinery and material is a good substitute for public account plan, where the state furnishes the capital. There

should be a graduated compulsory educational system; in addition to the common branches, physical geography, political economy, ethics, natural and moral theology, and technical instruction should be given. Pardoning power should be rare; release should occur only when there is reasonable security against further crime. There are about 46,000 penitentiary prisoners in the United States, and from a quarter to half a million of ex-convicts abroad in the community, which is the cause of most of the current crimes.

De la suggestion hypnotique chez les criminels, par le DR. EM. LAURENT. Revue de l'Hypnotisme, 1er Août, 1889.

The writer takes up in detail a hysterical individual accused of complicity in theft, and shows how that hypnotization is negative in results as to gaining a confession from the accused. The following conversation took place while the accused was in the hypnotic state:

Laurent. You are accused of complicity in theft. Patient. I am innocent. L. You knew however that the horse and carriage had been stolen? P. No, no. I didn't know anything about it. L. You knew it. P. I swear to you, I did not. L. I tell you, you did know it. P. No (already more softly). L. I assure you that you knew it, you knew it. P. Yes, I knew it. L. Are you sure you knew it? P. I knew it. L. (again). You did not know that the carriage had been stolen? P. Yes, I knew it. (Thus it is evident, that the will of the patient has been conquered by the will of the hypnotizer.) Dr. Laurent continues: You did not know that the carriage had been stolen. P. Yes, I knew it. L. No, I tell you, you did not know anything about it. P. No, I did not know anything about it. At this moment we do not know whether the patient knows it, or not. Dr. Laurent says that the present state of our knowledge does not permit us to know whether the person hypnotized obeys his conscience or his will, which holds him under its dependence. We may add that little children on the witness stand can be made through the overbearing manner of the examiner to confess things about themselves or others that have been solely suggested at the time.

Dr. Laurent has an article in the same review for November 1st, 1889, considering the influence of suggestive action over hysterical prisoners. A hysterical person is often wholly at the mercy of his surroundings. At one time he loves to engage in prayer, at another to go on a debauch. It is evident that such a person coming out of prison will be more dangerous than ever. The doctor cites cases from his own experience, where the prisoners have made their hysterical comrade believe all sorts of absurdities about himself. He terms this a sort of suggestion *(à froid)*, a hypnotism in the waking state; without doubt the suggestive action is less than in sleep, still it has its forces. He gives also an illustration of self-hypnotization in the case of a hysterical prisoner, who within a few days after his entrance into prison learns the customs, language and tastes of the place, and believes himself to be one of the greatest of criminals; he can be made to injure other prisoners. The practical conclusion of the article is, that all hysterical prisoners should be isolated, and placed under the charge of a physician, on account of the pernicious moral influence the prisoners have over them.

Should Inebriates be Punished by Death for Crime? By T. D. CROTHERS, M. D., Superintendent of Walnut Lodge, of Hartford, Conn.

Although this is only a leaflet of eight pages, it contains many facts and practical ideas. Criminals are found who are not deceitful, but desperately wicked. The inebriate is defective and diseased—the death penalty for inebriates is opposed to all teachings of science and experience. Ten per cent. of the estimated half million inebriates in the United

States are yearly convicted of crime; two per cent. commit capital crime, and one per cent. of this number, or about one hundred persons, are executed every year. Inebriacy is not a voluntary condition within the control of the person. In one thousand cases confined on Blackwell's Island, nine hundred and thirty-five had been returned for the same offence from one to twenty-eight times. The inebriate murderers are subject to delusions, morbid impulses, epileptic explosions, sometimes alcoholic somnambulism; the death penalty has no horrors for them; the first sentence causes others. Inebriate murderers should have a private trial, should be confined for the rest of their life in a military workhouse hospital.

Archives de l'Anthropologie Criminelle. Tome troisième. Paris, 1888. Chronique anglaise et anglo-américaine. Par H. COUTAGNE. pp. 702.

The writer refers in brief to the innovation of electricity in capital punishment. There are two objections to execution of the criminal by electricity: First from the frequent inconstance of electric currents. In England, in 1865 it was tried at the slaughter houses, and in spite of the energy of means employed they succeeded sometimes, but were compelled to resort to more certain methods. The second objection is more serious and will hold even if electricity in the hands of the executioner is made certain; it is, that the punishment by death can produce its preventative effect against crime only by virtue of a brutal method, which does not permit the least doubt as to its reality. Electricity will not produce this preventative effect, and will permit a suspicion of simulation. The writer's second objection is well taken. It may be said, however, that the cruel method, should it prevent a few murders, hardens at the same time the finer sentiments of the great mass of the people; on this basis the taking of life at all has an evil effect; also why should it be taken, if the method of doing it defeats the very end for which it is done? But a thorough statistical investigation rather than arguments may point towards a solution.

De la mort par l'électricité. D'ARSONAL. Archives de l'anthropologie criminelle. 1887.

Arsonal's experiments show that electricity can kill in two ways: (1.) By direct action of the discharge which causes instantaneous and irremediable death by the destruction of the tissues themselves. When a nervous, vascular or muscular tissue is excited by a discharge sufficiently intense to be compared to a thunderbolt, the tissue is completely disorganized, and loses forever its physiological properties. But (2), Death can take place by reflex action in exciting the bulbular centers, as a mechanical irritation would do it. This germ of excitation is accompanied by all the phenomena of action at a distance, studied by Brown-Sequard under the names of inhibition and "*dynamogénie.*" This is why the lesions are not regular, and can present an infinite variety, according to the variable point of the nervous centers excited. Death, artificially caused, is almost always due to an arrest of respiration, which being prolonged causes death definitely by asphyxia. The practical conclusion of the author is, that in the great majority of cases life can be restored on immediately afterwards applying artificial respiration.

IV.—EXPERIMENTAL.

Psychophysiologische Protistenstudien. Experimentelle Untersuchungen von DR. MAX VERWORN. Jena, 1889. pp. 217.

After an affectionate introductory note to his former teachers, Hæckel

and Preyer, the author laments that while it is everywhere recognized that the cell is the morphological unit of life physiology is more and more dwarfed and one-sided because it not only does not penetrate back to the cell, but is not yet even comparative. Of all branches of physiology this is most the case with psychology. Modern physiology rests almost solely upon studies made upon men, dogs, rabbits, guinea-pigs and frogs. Even lower vertebrates are neglected. Only by the study of the strangely fascinating lowest forms of life can we hope to reach fundamental knowledge of psychic phenomena and not by the study of single groups as the insects. Hæckel's consequent monistic ascriptions of an "*atom-soul*" to the final elemental factors of all physical and chemical processes in whatever form conceived, giving these force-centers the most rudimentary sensations and motions, and of a "*plastidule-soul*," endowing the smallest uniform part or molecule of protoplasm, and of a "*cell-soul*," as the total tension-force stored up in protoplasm, is a fundamental assumption of Verworn. Taste and touch mediate the instinctive movements of the lowest organisms. The copious literature of his subject to which one chapter is devoted shows that few zoölogists have assigned elemental psychic functions to protists, while some have ascribed to them very highly developed soul-life.

Movement is of course the only observable expression of psychic life. The many organisms were first collected mostly near Berlin, and their spontaneous movements systematically observed under the microscope and described for each group. Five grades of intensity of light, up to sunlight from a concave mirror, and also spectral colors were then applied as stimulus. Some protists showed no effect; on some light seemed to be inhibitory, in some it caused motion. Strasburger's "photometric" protists seemed tuned to a distinct intensity of light. Some protist varieties are "phototactic" to other colors or wave-lengths. It is doubtless true that selection strives in general toward kinds or intensities of light favorable to chemical processes that advance life and tends to avoid those that are unfavorable, although this tendency was not demonstrated in individual protists.

Temperature stimulation affected not only the power, but seemed in some cases to affect the direction of motion. These phenomena may be called thermotropism, as analogous to heliotropism, and may be best seen in *amœba limax*. Increase of temperature attunes to an higher, decrease to a lower intensity of light. Increase of heat is far more effective than decrease. Both after effects and adaptability are affirmed, but without details. The mechanical stimulus of jarring is still more effective, and thigmotropism (τὸ θίγμα = contact) and rheotropism are affirmed of rhizopods and ciliates. The great difference in sensitiveness of different forms to this stimulus is illustrated by numerous wood cuts. Acoustic stimuli had no distinct effect.

The number of chemical substances effective as stimuli is very large. Positive and negative chemotropism and Pfeffer's chemotaktic movements are very marked and are named chemometrie. Not only nutritive but indifferent and even noxious substances are attractive. Some substances are entirely without effect, however concentrated, and the threshold intensity of this form of stimulation varies greatly with different bacteria forms and different substances. Myxomycetæ are distinctly hydrotropic, while curara produces no effect upon ciliary motion; chloroform causes complete narkosis, destroying the power to react to otherwise effective stimuli. Most remarkable is the chemotropism for oxygen for which most protists have a passion. Galvanic currents cause distinct movements, and ciliates turn toward the cathode along the current lines. Geotropism or sensitiveness to gravity is doubtful.

Protists have no demonstrable "organoids" for any of the above forms of stimuli unless ciliae, pseudopodia, etc., aid in the sensations caused by mechanical stimuli.

The last third of the book is devoted to a brief analysis of human psychic activities and an argument that from the automatic movements of protists, something like faint rudimentary unconscious concepts may be assumed, and from their reflex movements unconscious sensations may be inferred, or at least are probable. The parts of divided protists make nearly the same movements in response to all the above kinds of stimulus as the entire animal, only the smaller the part the greater strength of stimulus is needed. Hence the nucleus is not the psychic centre, and "every elementary part of protoplasm has its own independent psyche." Ciliates are physically highest, rhizopods lowest among protists. The movements described, our author believes, are "identical with the molecular processes in protoplasm." There is no distinction between psychic and physiological movement. It is impossible to separate the idea of psyche from the idea of life. While it is proved that this molecular psychology is the most primitive, it remains to demonstrate what is already undoubted, that these processes are the bridge to connect the chemical processes of inorganic nature with the soul-life of the highest animals. As the vital processes in man are related to those of a cell, so are the latter to those of elementary parts of protoplasm, and so again are these last to the processes in any molecule whatever. This is the lofty monism which Demokritus, Bruno, Spinoza and Hæckel have attained, for which all differences between organic and inorganic, between psychic and material processes have vanished, and is to all dual or manifold ideas of the universe as of old monotheism was to all polytheisms.

Der Heliotropismus der Thiere, und seine Uebereinstimmung mit dem Heliotropismus der Pflanzen, von DR. J. LOEB, Assistent am physiolog. Inst. zu Strassburg. Würzburg, 1890. pp. 118. Preis 4 mark.

In his *Vorlesungen über Pflanzen-Physiologie* (2nd ed., Leipsic, 1887.) G. v. Sachs has summed up his remarkable experiments on heliotropism and kindred topics of plant life. Loeb (taking Sachs as his model) attempts to demonstrate all the same laws on lower animal forms, mostly insects. He began with a spinning species of caterpillar (*Porthesia Chrysorrhœa*), of which he put 100 in a reagent glass, and found however often the direction of the glass was reversed they always crept towards the light. If the end towards the light was covered by an opaque sheath they crept light-wards as far as the first edge of the sheath, and there paused. They will leave a lighter part of a tube and pass a long darker passage which opens towards light. They pass out of a ray of direct sunlight into shadow, or vice versa, to get nearer a source of light. For these, as for nearly all insects tested, red and yellow light are much less effective than blue and even violet, and ultra violet has little effect, and all these experiments work only at certain temperatures. Each insect showed the all-constraining tendency to bring the median plane of its body in the direction of the ray at a certain intensity varying with the species, and every insect showed the tendency if proper conditions were observed, so that there was no laborious counting of "parliamentary majorities," as with Lubbock's and Graber's ants. The effect of this stimulus was constant and the insects remained for days as near the light as they could get, and constantly "pointed" at it. Heliotropism is best studied in nearly horizontal directions to eliminate geotropic influences, the latter being however far weaker.

Why moths that only fly by night love the light is made no less a paradox by Romanes' anthropomorphic remark that a candle is a strange object they would examine. By artificial day and night Loeb could change their daily time of flight or rest but a few hours. All night flies so far as studied, are *positively* heliotropic, and never shun light itself. What seems the passion of so many creeping insects for corners,

cracks, and edges, and their dislike of open surfaces, is another confusing element to be eliminated, though weaker than heliotropism, and is named contact-irritability, or stereotroprism. All these experiments are in general very simple and require almost no apparatus beyond glass cups, tubes, a window that can be partly darkened, and a prism.

Leaf-lice at rest usually turn the oral pole toward the stem, the aboral to the apex of a leaf, or lie in this sense along its veins if at rest. As soon as their wings grow, which may be caused artificially by gradually drying up the leaf, their orientation becomes heliotropic and independent of the leaf and very serviceable for these experiments. At the time of sexual maturity, or at the time of the "wedding flight," many insects become strongly heliotropic, when they are not so before or after. The tendency is to get the axis of the body in the direction of the ray of light, rather than to seek the strongest light. In one case with a rotatory polarization apparatus turning 3-4 times per second with a radius of 30 cm., a fly went round with the ray several times, thrice repeated. This observation of Mach, Loeb thinks, illustrates the constraining power of heliotropism. It might readily be carried further by a centrifugal machine. The protoplasm in the background of the human eye is positively heliotropic; pigment and cones press forward, if illuminated. The heliotropic conception of retinal space-sensations pre-supposes the *continuity* of protoplasm as the irritable substance, and rejects the theory of distinct visual elements—rods and cones. Heliotropic changes determine space-sensations, and this new view simplifies many problems. Heliotropism cannot rest on any specific properties of a central nervous system, for it is common where there are no nerves.

This pamphlet is very interesting, abounds in facts and suggestions and must be read to be fully appreciated. The work was undertaken to show—so we are told at the outset—that in all these phenomena there is no evidence whatever of sensation, instinct, preference, or anything whatever of a psychic nature. All heliotropic, geotropic, stereotropic, or thermotropic motions whatever are in their nature absolutely identical with analogous movements of plants, and he who wishes to see any rudiment or analogue of a bank of intelligent Raphael faces gazing on a central glory, as mediæval artists often dreamed of, in a mass of maggots or larvæ or caterpillars, every one flush with the edge of glass or beaker-rim nearest the light, and staying there for days, should here learn the far higher lesson of law and mechanism, such phenomena properly inculcate. The view of Loeb is in fact as speculative on one side as the anthropomorphism of Verworn (above) is on the other. The violent polemic tone of Loeb and his dogmatism on this old and purely theoretic, and as yet unanswerable question, the entire absence of all morphological or anatomical considerations, especially with the author's mechanical predilections and the *very* meagre evidence suggested to even countenance his revolutionary view of retinal space-perception, are each in different ways to be regretted. His work, however, opens up still wider a new and attractive field, wherein we hope to see psychology gradually strike many strong and deep roots into the rich soil of general biology.

Der Zeitsinn. MÜNSTERBERG. Beiträge zur experimentellen Psychologie. H. 2. 1889.

The second number of Münsterberg's series of psychological studies opens with an article in the much-confused field of the "time-sense." After résuméing the results of previous experimenters, from Mach to Glass, and presenting at length (three-fifths of the whole paper), the theory to which he has been led by self-observation in the course of experimentation, he finally gives in a brief section the results of an experimental test of his theory. This theory is nothing less than a

complete denial of the existence of a "time-sense;" that is to say, our estimates of time, short intervals as well as long, are not made by an independent sense, but by more or less completely unconscious observation of internal physiological states, especially muscular tensions. Time judgments rest on a kind of psychic synthesis of the sensations that mark the intervals and those that indicate the state of muscular tension, as visual space judgments on the synthesis of visual and muscular sensations. Take a simple example. The subject is given three distinct sounds, the first and second beginning and ending a standard interval with which the subject is to compare that marked off by the second and third. The entrance of the first sound calls up reflexly an adjustment tension in the muscles of the sense organ, which reaches a maximum and declines. At some stage of the decline the second stimulus enters, causing a renewed tension, followed in turn by a decline like the first. Now, if the third stimulus comes at a stage of decline corresponding to that at which the second came, the interval is pronounced the same; if it comes when the decline is less or greater, the interval is judged shorter or longer than the first. For very brief intervals a similar rôle seems to be played by the sensory "memory-after-image," and for longer ones by the widely irradiated tensions and relaxations accompanying respiration. Into the author's extended exposition of the last, and of the complications introduced into it by attention, etc., we shall not enter here. Suffice it to say, that by his theory he explains the very great variety of "intervals of least error" found by different observers (from .4 sec. to 1.25 sec.), the occasional anomalous series reported by some experimenters, and the striking periodicity of the "intervals of least error" observed by others.

The experimental section (only one fifth of the whole, and then not unduly compressed), presents three series of experiments made upon Münsterberg himself; those made on other subjects are only referred to. They were all made with the time-sense apparatus of Wundt, somewhat bettered, and by the method of average error. In the first series the subject was given two sounds marking an interval (6—60 secs.), and required to make a third when the interval after the second sound had become as great as that before it. When the first two sounds were so given that the second always occurred at the same respiratory phase as the first, the average error was 2.9 per cent.; when this was not regarded, it was 10.7 per cent. In the second series three sounds were given, the first and second beginning and ending the standard interval; and the third, at a varying time from the second, beginning the comparison interval, which the subject observed and closed as before. This time the error, when respiration was regarded, was 5.3 per cent; when it was disregarded, 24.0 per cent. In the third series, Münsterberg consciously withdrew attention from the sensations of tension and relaxation, to the complete confusion of his time-judgments, making 4 seconds seem like 12, and 9 like 3.

Münsterberg is certainly right in looking for the explanation of the "time-sense" in the effect on consciousness of physiological processes, and his contribution is an interesting and suggestive one, especially as regards the discordance of previous experimenters. At the same time most of his experiments have to do with considerable intervals, (his explanation of the judgment of short intervals by tension in the sense organs, is left still in the theoretical stage), and are not numerous nor varied enough to exclude other possible influences in addition to that of respiration.

Schwankungen der Aufmerksamkeit. MÜNSTERBERG. Ibid.

When one attempts to observe a very faint sensation, the barely audible ticking of a watch or the line of separation between the faintest

gray ring of a Masson's disk and the adjacent wholly white one, the sensation comes and goes at somewhat regular intervals. After an experimental study of the phenomenon, N. Lange came to the conclusion that the cause was central and the variation a rhythm of apperception. (*Phil. Studien*, IV, 390 ff.) This view is vigorously attacked by Münsterberg. The experiments upon which he rests his attack were as follows. The subject fixed his eyes and attention on the line of demarkation of a Masson's disk 2 m. distant, and recorded the ebb and flow of sensation by moving with his finger a lever adjusted to write upon a revolving drum, the finger rising as the sensation intensified and falling as it faded, through a period of from 60 to 80 secs. In the first series the average length of time from the beginning of one disappearance to the beginning of the next was 6.9 secs., (Lange, 3.1–3.4) with a mean variation of 1.1 sec. The subject noticed faint sensations of motion in the eyes accompanying the fluctuations. In the next series, prisms were brought before the eyes and removed alternately for periods of two seconds, causing a deviation of the eyes without disturbing the vision of the rings; the result was a lengthening of the period to 12.3 secs. Voluntary closure of the eyes every second or two seconds generally prevented the fluctuations, while the interposition of a gray screen before the disk, though interrupting vision for a slightly longer time, increased their rapidity, making them now recur in 5.8 secs. More rapid interposition and removal of the screen caused a lengthening of the periods; and when the disk was covered continuously for a full second out of every four, the continuity of the sensation was broken up and no fluctuations were found. Observations with indirect vision gave a rate of 8.2 secs. Continuous movements of the whole disk up and down or from side to side at the rate of 10 cm. per second, bringing it to its original position every four seconds, caused total suspension of the periodicity. Very rapid breathing quickened it to 5.1 secs.; slow breathing slowed it to 8.5; but the periodicity did not seem causally dependent on respiration. Several of these tests were also tried with similar results by the observation of a black dot on a large white field. The chief points in the interpretation of these experiments, to which a long section is devoted, are as follows. The whole group shows the phenomenon in question to be of peripheral and not central origin, (else why the profound effects of purely peripheral changes?) and in particular from the fatigue of the muscles of fixation and accommodation. The prisms lengthened the period because the deviation of the eyes which they caused relieved the fatigue of fixation and lessened that of accommodation; the winking experiments relieved the latter and so prevented the failure of accommodation, and thereby the disappearance of the demarkation line on the disk. The interposition of the screen had the contrary effect because it did not relieve accommodation, but rather made it more difficult. In a similar way the other experiments support the muscle-fatigue theory; and what is thus demonstrated for the muscles of the eye, Münsterberg carries over to the less accessible muscles of the ear. The experiments form a valuable contribution to the subject and are demonstrative on the point immediately in question, to wit, the very important function of the periphery in the variations of faint visual sensations. Some portions of his critique upon Lange, however, seem to us less sound, and indeed in explaining Lange's experiment with faint stimuli to two senses at once he introduces central processes (in a secondary position, to be sure) not unworthy the name of changes of attention.

Augenmass. MÜNSTERBERG. Ibid.

After the usual historical and critical review the author makes preliminary report on the results of a comprehensive study of the conditions

affecting visual estimation of the separation of points and the length of lines. Besides this immediate object the author explains the aim of his experiments to be the examination of how far eye movements, or rather variations in the intensity of the sensations accompanying them, are responsible for visual judgments, all this forming part of a plan for demonstrating that the comparison of sensations, etc., (generally conceived to be an act of consciousness as opposed to a content of consciousness,) is in reality itself a content and not an act. The 20,000 observations already made by Münsterberg are distributed in groups of from 400 to 800 among 36 variations of condition. The apparatus used was simple and convenient; the method was a modification of that of average error; the 20 standard distances used ranged from 1 to 20 cm., by differences of 1 cm.; the experimenter worked on himself. The variations included the use of empty spaces and horizontal and vertical lines, seen monocularly and binocularly, with and without motion of the eyes, and in the indirect field, with reproduction at different time intervals after seeing the standard, etc., etc. A bare statement of the final figures in these 36 cases would unduly lengthen this notice; some of the more general conclusions are as follows. The experiments show decidedly that changes of motion, position or use of the eyes produce marked changes in the estimate of distances, to be explained only by the participation of sensations of motion or their memory images; these cannot be given a secondary place in any theory of vision. Empty distances on the right were under-estimated, on the left over-estimated, a fact which the author connects with common practices in reading and writing. The eyes when used separately each over-estimated extensions on its own side. Extensions reproduced after an interval were generally over-estimated, especially the smaller ones; the reproduction was much more accurate if the reproduced lengths occupied exactly the same position as the original. Lines did not seem greater than equal empty spaces, a seeming contradiction of the commonly recognized illusion which Münsterberg, however, explains. Broken lines seemed as usual too long. Lines, unlike empty spaces, were reproduced smaller in both halves of the field, because, as it seems, the eye does not traverse the whole of the standard line, judging partly by indirect vision, and does traverse the whole of the line reproduced, thus giving the latter more sensation of muscular effort. Münsterberg finds the commonly accepted over-estimation of vertical distances only on three conditions, namely, when the distances are empty, the vertical is above the horizontal with which it is compared, and the eyes are free to move. Distances above the horizontal seem longer than equal distances below, if both are of considerable length. Turning from the constant to the variable error, the true measure of the differential threshold, the experiments show it much greater when the eyes are fixed, the difference being due to the fact that in the first case the judgment is based on motions actually executed and in the second on the remembrance of such motions. The variable error is increased or diminished by one and another of the conditions examined; but, other things being equal, Weber's Law holds with a reasonable exactness for the distances experimented upon. What it really applies to, however, is not the estimation of visual extensity, but to the changes of intensity in the motor sensations of the eye.

Raumsinn des Ohres. MÜNSTERBERG. Ibid.

The author's theory of the auditory perception of space, arrived at in the original after an examination of previous experiments on sound-localization, and on the functions of the semicircular canals, is briefly this. Sounds differ according to the direction from which they come, independently of changes in quality, intensity, etc., in the disturbance which they produce in the semicircular canals. With these differ-

ent disturbances are reflexly connected the movements necessary to bring the point, from which the sound comes, into the median plane of the head where hearing is most distinct and the cause of the sound may be best investigated by other senses. By a synthesis of the motor sensations thus produced, or their memory images (not necessarily conscious), with the auditory sensations, similar to the synthesis affirmed by the genetic theory in the case of sight and touch, an auditory space arises. Münsterberg's own experiments only remotely touch the question of the organ by which these variations of sound are mediated, and in our opinion he would have greatly improved his paper, as he certainly would have shortened it, by giving a very subordinate place to this whole phase of the question. The immediate point of his experiments was to determine the least observable change in the direction of a given sound. Most of the experiments were made at different points on the circumference of three circles about the head, one lying in the horizontal plane passing through the line connecting the ear-drums, one in the vertical plane passing through the same line, and one in the median plane of the head; the radius of these circles was 1 meter. The stimulus was the clicking of the head of a stem-winding watch, and was given three times at a chosen point (16 equi-distant points were tested in each circumference), then after a second's interval three times again at a slightly different point till the just observable change was determined. The general results were as follows. In the horizontal circle the point of greatest exactness was immediately in front where a change of less than 1° was recognized; the sensibility declined continuously to the point of least exactness immediately behind the head where the least change was nearly 6°. On the frontal-vertical circle the points of greatest exactness were directly opposite each ear, and directly above and below the centre points of the head. On the median circle the point of greatest exactness was 45° below the horizon (and horizontal changes also were here recognized with great exactness), thus coinciding with the point of vision when the eyes are, as commonly, somewhat depressed. Other points of maximal exactness were directly over the head and directly behind it. When one ear was stopped and tests again made in the horizontal circle the exactness was decreased not only on that side, but also on that of the open ear, showing that normally both ears co-operate in localization. When the outer ear was covered inside and out with wax, the sensibility to changes in front was decreased, but for changes in the rear was uninfluenced. The connection of the results with the theory is simplest in the case of the horizontal circle, though the author traces it in all. There the sensibility to change falls off as the muscular tension required to bring the place of sound into the median plane becomes greater; no change of place is perceived unless sufficient to produce a perceptible change in muscular tension. If the discrimination depends on the sensations of muscular contraction, it should follow Weber's Law; and, though no exact quantity can be assigned to the increasing tension, there is a striking correspondence.

Ueber Contrasterscheinungen in Folge von Einstellung; Eine vorläufige Mittheilung. Dr. F. SCHUMANN. Nachrichten v. der k. Ges. d. Wiss. und der Georg-Augusts Universität zu Göttingen. Dec. 3, 1889. No. 20. pp. 5.

In the course of a research upon memory after the general method of Ebbinghaus (now going on at Göttingen), Dr. Schumann noticed certain illusions of contrast, which he has interestingly described and brought into relation with similar effects in other fields of sensation. Nonsense syllables are cut out, fastened to a strip of paper, and rotated on a drum; they are viewed through a slit in a screen allowing just one syllable to be seen at a time. A normal rate of rotation is chosen, so that the sylla-

bles can be conveniently read for committing to memory without haste or delay. Dr. Schumann observed: (1) That when the drum was going too rapidly and he set the rate to reduce it to the normal speed, this latter then seemed too slow; (2) that if the subjects were mentally tired the normal speed seemed unusually fast, while if they were fresh it seemed slower than usual. They are both due to the carrying over of mental impressions to changed conditions; when the drum is going a little too fast it takes a greater strain of the attention to follow the syllables; a lessening of this strain seems by contrast to reduce the speed more than it really does. So when tired we interpret difficulty of keeping the attention as increase of speed of impressions. So in time experiments in passing from one normal interval to a longer the second seems unusually long, and vice versa; we seem to have a time (.7 seconds) in which impressions are conveniently attended to. When they come more rapidly we have to strain the attention to follow them; when more slowly we have to wait for them. A similar fact was observed in the motor field. If one hand moves over a normal space of 20 cm. and the other hand moves over a space of 17, 18, 19, 20, 21, 22, or 23 cm., to judge which is longer, then in moving over a space of 23 cm. the hand will frequently move rapidly the first 20 cm. and then slowly, the space moved over seeming unusually long. Here a certain motor innervation is ready and if exceeded makes the space seem unusually long. More extended observations are in progress.

Zur Lehre von der Willensthätigkeit. J. ORSCHANSKY. Archiv für Anat. u. Phys. 1889. Phys. Abth., 3–4, p. 173.

What is the nature of the difference between the two distinct kinds of exercise of the will,—the act of impulse and the act of inhibition? Is the one a setting free of energy, the other a storing of it up (Wundt)? Do they take place in different parts of the nervous system (Sietschenow)? Is it a case of simple interference of waves (Cyon)? Do these waves proceed in different directions (Goltz)? Does the struggle between the two take place in the nerve-center, the nerve or the muscle; or is the suppression of the action of one set of muscles brought about by the action of the antagonistic set (Munk)? This latter view seems plainly untenable on account of the fact that some muscles, as those in the region of the N. faciales, have no antagonists. The experiments of Orschansky were performed on the M. masseter on account of its being among the autonomous muscles, strong, of constant attachment, and admitting of easy registration of its action. They seem to show that the reaction-time of inhibition does not differ, after a brief period of practice, from that of the direct impulse. But the reaction-time of the impulse consists of four moments: (1) The passage to the sensory center, (2) the sense-perception, (3) the act of will, (4) the motor impulse; and it would be very improbable that the reaction-time of the inhibition should be wanting in any of these stages and should still be of the same duration. Moreover, very different reaction-times were obtained by varying, separately, the tension and the amplitude of the muscular excursion, and in every case the change in the inhibition-time follows closely upon the change in the impulse-time. (The author's explanation of the seemingly anomalous effects produced by these two moments does not seem to be very clear.) The effect of pathological conditions is also the same upon both. From this it seems natural to conclude that the anatomical circuit is the same for both species of exercise of the will. C. L. F.

Untersuchungen über die Empfindlichkeit des Intervallsinnes. IWAN SCHISCHMÁNOW. Philosophische Studien. Bd. V., H. 4.

Schischmánow subjects the entire problem of the sensibility to intervals of tone to a thorough and independent re-investigation. He pre-

faces his account of his results with an interesting historical introduction, forming an admirable résumé of the topic. His own experiments consist in setting a movable weight upon a tuning fork, so that the resultant tone forms just a given interval with a constant fork; and, again, in finding the point at which the falsity of the interval is detected above and below. He then groups and averages the results, expressing the sensibility as the just perceptible portion *of a vibration per second* from the true interval. For Schischmánow, who is musical, and a fellow student K., who is not, the results for the different intervals thus expressed are: *Octave* (2:1), S 0.220, K 0.356; *Fifth* (3:2), S 0.332, K 0.374; *Fourth* (4:3), S 0.419, K 0.403; *Third* (5:4), S 0.485, K 0.559; *Major sixth* (5:3), S 0.502, K 0.506; *Second* (9:8), S 0.548, K 0.716; *Minor third* (6:5), S 0.607, K 0.640; *Minor sixth* (8:5), S 0.672, K 0.740; *Minor seventh* (9:5), S 0.678, K 0.763; *Major seventh* (15:8), S 0.861, K 0.902. While practice and individual differences play some part, the order as presented by Schischmánow, especially for the four best and the three worst appreciated intervals, may be taken as normal, and agrees very well with the order determined by Helmholtz, on the basis of the relative consonance of overtones, though Schischmánow does not regard this as the sole factor in the sensibility.

Die Seelenthätigkeit in ihrem Verhältniss zu Blutumlauf und Athmung. Prof. Dr. ERNST LEUMANN. Philosophische Studien. Bd. V, H. 4.

This "lay" contribution is suggestive rather than positive, its object being to call attention to the desirability of noting pulse and respiration rates in connection with psychometric determinations. The failing of words to speak, as well as power to speak them, when out of breath, or physically weary, the slowing of pulse and respiration in drowsiness and sleep, illustrate the general relation in question. As suggesting the kind of relation experiment may establish, Prof. Leumann found in one subject a pulse of 77 when scanning at the rate of 113 feet per minute, and 83 when scanning 140 per minute. Of two gymnasium students, one with a pulse of 85 read 107 feet per minute normally, another with a pulse of 98 read 129 feet per minute. In a rather more accurate test the pulse rate was found to increase as the rate of reading increased. If pulse and respiration rate were noted, we might explain small variations now regarded as accidental. Again Prof. Leumann brings the pulse rate into relation with association times, with the indifference point in the time sense, and the respiration time into relation with the waves of attention, *i. e.*, the periods in the appearance and disappearance of a very faint sensation, but the relation is only a distant analogy. It would be interesting to know whether the waves of attention are larger in slow breathers than in rapid breathers, and so on.

Recherches sur les mouvements volontaires dans l'anesthésie hystérique. A. BINET. Rev. phil., Nov., 1889.

Binet continues his interesting studies in hysterical hemianæsthesia, this time reporting experiments on voluntary motion. By the use of the dynamometer and the dynamograph he has compared the voluntary movements on the sound and diseased sides in respect to intensity and duration, and by reaction-times as to rapidity. The following are the general results found in the case of the subjects on which he worked, for which, of course, he does not claim universality. Two types of activity can be traced, one generally found on the sound side, the other generally on the anæsthesic. The curves representing the first type differ from those representing the second in their greater height and their more rapid rise and descent. In that type also the reaction-time is shorter. Fatigue, however, appears more quickly, betraying itself by irregular respiration and tremors in the acting member. This last is in marked

contrast to the other type of action; the anæsthesic type can sometimes be maintained for long periods in fatiguing positions, (if the muscles are not put to a maximum exertion), without fatigue. Points of resemblance in the long continuance of moderate contraction are shown between this second type and suggested catalepsy and contractures. These types were not found in all subjects, nor must they be too closely connected with sensibility and anæsthesia. From the detailed observations of the article we cull the following. In hysterical hemianæsthesia the sound side is generally increased in power, in hysterical hemiplegia even more so. The dynamometric pressure is greater in each hand when acting by itself than in conjunction with the other, (a fact which Binet explains by the difficulty which hysterics experience in dividing their attention); the bilateral dynamographic curves are longer and flatter than the unilateral; and the reaction-times are much longer for both hands, especially on the anæsthesic side, when reaction is made with both hands than when each reacts by itself.

Recent experiments in crystal-vision. Proc. of Soc. for Psych. Research (Eng.). June, 1889.

The first half of this paper is devoted to an interesting historical account, from which it appears that "crystal-vision," under various names and making use of various reflecting surfaces, (bowls of water, gems, mirrors, pools of ink in the palm of the hand, sword blades, and even finger-nails), some times to communicate with the gods, some times with devils, openly or under ban, has been practiced for 3000 years in Europe, Asia, Africa, and the ends of the earth. The crystal-gazer looking into some one of these polished surfaces sees more or less elaborate visions. The lady who contributes the article has herself this uncommon faculty, and speaks from personal experience of upwards of 70 cases. If she has a grain too little skepticism as to telepathy, she nevertheless approaches the subject in an eminently matter-of-fact and open-minded fashion. Her experiences fall into 3 groups: "1. After-images or recrudescent memories, often rising thus and thus only from the sub-conscious strata to which they had sunk. 2. Objectivations of ideas or images (*a*) consciously or (*b*) unconsciously in the mind of the percipient. 3. Visions, possibly telepathic or clairvoyant, implying acquirement of knowledge by super-normal means." Under the first come casual impressions *e. g.* of objects seen on a walk, completely forgotten, later seen in the crystal, and with difficulty traced to the original circumstances. Under the second are classed (*a*) the images called up by the gazer, (*e. g.* groups of figures that, once voluntarily projected into the crystal, go on to actions quite unexpected by the gazer), or things that lie "on the mind," though not actually in consciousness; (*b*) odds and ends of images from the unconscious, to which the author refers as in general "so grotesque and commonplace" as "not to administer greatly to one's self-esteem." Of the third class not very many are reported, and none of these have reference to important events, unless it be one, which may be taken as a sample of all, where the crystal revealed a man with a muffled face looking into a small window from the outside, an image which was realized a few days later in the case of a fireman when the house was on fire and a muffled-face fireman looked into such a window. Some of these visions were so fully objective that their parts could be enlarged with a magnifying glass. The author confesses to more than ordinary powers of visualization without her crystal.

Versuche über den Einfluss des Schlafes auf den Stoffwechsel. H. Laehr. Allg. Zeitsch. f. Psychiatrie. 1889. p. 286–317.

While the amount of nitrogen given off does not change, it is known that in sleep less carbonic acid is given off and less oxygen is taken up

by the system, or less fat but the same amount of albumen is decomposed. Laehr divided the day into three equal periods of eight hours, at the beginning of each of which he urinated, was weighed and took food of exactly equal kind and amount. By these more constant conditions than have been hitherto observed, he slept from 11 to 7. From these experiments which have been repeated at intervals for more than eight years, the following results were reached: Sleep is attended by a decrease (not an increase as Quincke had said) in the amount of urine secreted, its acid reaction is greatly reduced, its chloride is much decreased, and urea and sulphuric acid are slightly less. A recumbent position causes slight increase of urine and of the above substances, as well as of phosphoric acid. The latter, as well as lime and magnesia constituents of urine are unaffected.

V.—ABNORMAL.

Beitrag zur Lehre von der Infectiosität der Neurosen, von Dr. B. HERZOG. Arch. Psychiatrie, 1889., p. 271.

In psychic infection, induction, or contagion, which Werner has lately denied, while Wollenberg ascribes to it a greater rôle than was ever suspected before, is predisposition all, or is there a very specific effect, and if the latter, does it work upon the secondary subject while he is only passive or has his imitative instinct causal action? From two interesting cases the writer concludes that imitation is a part of the disposition, or a symptom of already existing disease. The second individual is as passive in his imitation as in hypnotic suggestion.

Ueber das Symptom der Verbigeration, von Dr. C. NIESSER. Allg. Zeitsch. f. Psychiatrie, 1889, pp, 168–232.

Although first described in connection with Katatonia by Kahlbaum in 1874, this symptom has been little studied. It is a "speech-cramp" which may occur with very diverse, but not with all dysthymia. It is a symptom of as great dignity and independence as idea-flight, or auditory hallucinations. Its characteristics may occur in the writing of the insane as well as in their speech. It is very diverse in its manifestations. A fragment of prayer, a single word, or interjection hissed between the teeth, whined, mumbled, low or loud, fast or slow, perhaps with florid gesticulation, are long repeated; or discourse and even writings with frequent repetitions mark these cases. It is more often associated with states of motor inhibition. From many heterogeneous cases an unitary etiological conception is sought.

Die Hallucinationen im Muskelsinn bei Geisteskranken und ihre klinische Bedeutung. Dr. A. CRAMER. Freiburg, 1889, pp. 130.

Centripetal nerves from muscles, whose specific energy it is to bring motor sensations to the brain, play an important rôle in paranoia. Their disorders may excite hallucinations in the locomotor apparatus, causing imperative motions, attitudes and acts; in speech mechanisms, causing loud-thinking and imperative speech; or in the eye muscles, causing illusions concerning motions, direction of motions, size of objects, etc. These rubrics are illustrated and confirmed by well selected and treated clinical histories.

Les agents provocateurs de l'hystérie. G. GUINON. Paris, 1889, pp. 392.

This work is full of most carefully selected and interesting casuistic material. The causes are: 1. Moral, as education, imitation, hypnotic experiments; 2. Shocks, like wounds, earthquakes, lightning; 3. Infections, as typhus pneumonia, malaria, scarlatina, rheumatism; 4. Weak-

ness, from loss of blood, anxiety, masturbation, intoxication, etc.; 5. Diseases of the nervous system. The only true cause of hysteria is heredity, and the above are only provoking agents. All the neuroses due to these causes are hysteria only, which is not complicated in such cases with neurasthenia, as is often held in Germany. The disease may follow the exciting cause at once or after years. Its genesis may be either auto-suggestion or mal-nutrition. Charcot's mechanical jar and Westphal's toxic encephalopathia saturnina are not admitted.

Les Névroses et le Pessimisme, par le DR. A. DESCHAMPS. Paris, 1888. pp. 37.

"La Névrose" is now almost a religion, of which Schopenhauer is the father, Charcot the high priest, and a well known French female tragedian [S. B.] the living ideal. Neurotics are those suffering from moral malaise. For some every sensation, even those called pleasant, is a cause of pain, and every movement fatigues. Their state is a sad *supplicium neuricum*, the fluctuating humors of which fill the neuropathic autobiographies with their morose, irritable, bizarre and sometimes, alas, contagious states, feelings and sensations even in gay Paris. Neurosis democratizes, but far more truely does democracy neuroticize. Liberty and equality modify profoundly conditions and habits. Desires and ambitions are enormously expanded, and the type of Obermann, Werther, Manfred and René, has been followed by the type of Schopenhauer, Tourgeniew, Tolstoi, Darwin, Mill, Spencer, and that by a still more serious type that kills, and now calls loudly for the doctor. Men are declassed, pleasures too easy—in a word, sensibilities are too distracted and will too enfeebled, and pessimism and nihilism are but the grand neuroses of our period. Children are too tenderly reared. The father, instead of being an object of silent respect, is the playmate, if not a slave of his child. Religion, politics, society, marriage, everything is an open question. Everything is criticized and, worst of all, analysed. General ideas are cheapened by cheap philosophical teachers who tend if they do not try to make their pupils Amiels and Bashkirsteffs, and who deserve the woe Goethe pronounced upon "every sort of culture which destroys the most effective means of all true culture." This wretched neurosis of irresolution makes *aboulia* the dominant note of this castrated age, best described, not in text-books on vesania but in the masterly pages of P. Bourget, himself severely afflicted with the distemper. It is seen in the poetry of Baudelaire, that dandy of spleen, paradox and subtlety, who passed his life in the hunt for new sensations; in Lecomte de Lisle, whose vaunted desolation would be a trifle magnificent, were he not a pure dilettante; in Verlaine and Mallarme, the Siamese-twins of decadence; in Maurice Rollinot, Albert Wolff and E. Haraucourt; in Goncourt, whose heroes are all without will and force, and martyrized by their impressionability; in Flaubert, who cries out that he would he were matter. Vague thoughts, aimless longings, despairs without cause, reveries that become passions, educations that stultify, instead of develop instincts and heredity; these are the marks in modern music, painting and life. A great crisis is upon this age, and is to be met somewhat as Caro has suggested as follows: The illusion of liberty must be eradicated at every point; an absolute must be insisted upon in state, church, society, science, which no supersubtle analytic mind must be allowed to touch. The ideals and faith in something transcendent, abiding and too mysterious for definition, must be cultivated, and a new education must arise, which will not teach more method than matter, and which will not culminate by teaching a philosophy which makes young men anxious about either the moral or the logical character of the universe, or the reality of their own ego or of the external world.

VI.—MISCELLANEOUS.

Die psychologische Forschung und ihre Aufgabe in der Gegenwart; Akademische Antrittsrede von DR. H. SPITTA. A. o. Prof. der Philos. Tübingen, 1889. pp. 36.

The lofty object of such inaugurals is, we are told, to state matters of deepest interest, and what serious and long work has disclosed as the most worthy good of life. The specialist must turn to philosophic thought, the fountain of perpetual youth for all sciences, where all these latter have their root in the natural psychic life of man, as all art must occasionally look back to its foundations in nature. Every science now shows a psychological side, and formulates its own basal problems in psychological terms. This progress is in part conditioned upon their penetrating further into the "why of why." Metaphysics has least interest in psychology and has declared war upon her late declaration of independence, but metaphysics is a product of individual thought about experience, and a somewhat aborted, branch-product of psychology. Cause, purpose, worth, good, and all the root-ideas of ethics, now that it is going into the large sociological field, need more or less radical psychological reconstructions. Man and his faculties are not only the measure of all things, but are becoming the burning questions of science. "Know thyself" is a psychological and not merely an ethical mandate. The nature of the ego and of religion, the very ideas of revelation, faith, belief, have been far too shallowly conceived to bear the strain they now must bear. "*Rechtpsychologie*" has arisen as a "colony" or "*enclave*" beside jurisprudence, and forensic or criminal psychology tries to improve our ideas of such psychic states and processes as are designated by such terms as "attempt," "intent," "free act," "guilt," "atonement," "punishment," "responsibility," and also postulates a better explanation of antilogies and paradoxes of willing, and even of volition itself, and determinism, and indeterminism. The problems of morbid psychology, the statics and mechanics of the folksoul are also growing more urgent.

All this shows that psychology is so closely connected with other departments that all attempts to dissect it out of these connections and place it on an independent basis, and give it a single exact experimental-physiological basis are to desoul it. Wundt's hope that every German university will soon have a psychological laboratory, and all conceptions of psychology as "the physics of the nervous system" would give us a psychology with no philosophy in it. This method can never explain conscience, remorse, wit, mood, or any complex side or question of psychic life. Soul is adaptation and cannot be isolated. The mathematical natural-history psychology will never bring all sciences into nearer and fruitful relations with each other, as all the work of the human psyche. This can only be done by methods of self-observation. (The author is evidently in close sympathy with Lotze. Apart from a few incidental expressions of Wundt, we recognize nowhere any tendency whatever to "isolate" psychology, nor to make it "independent" of any methods or results in any branch of human knowledge, even the introspective philosophy so far as it can be helpful. REV.)

Ueber Phantasie-Vorstellungen, von ANTON OELZELT-NEWIN. Gratz, 1889, pp. 123.

Notes and choice quotations from voluminous reading in general literature and in morbid psychology, conveniently grouped into an external unity which allows the whole to be divided into chapters headed: Ideas, properties, conditions, development, physical relation, and animal phantasy, the quotations well chosen and strung together by general remarks of a neutral tone that set them off to good advantage, makes a book not illy adapted to interest and instruct the general reader.

Manual of Empirical Psychology, by G. A. LINDNER, translated by Charles DeGarmo, Ph. D. Boston, 1889. pp. 274.

Although the author is still a professor at Prague and sanctioned and prefaced this translation, and although dreams, insanity, mesmerism, the will, ego, senses, etc., etc., are all given paragraphs or chapters, the book bears no trace of anything done in these or any other psychological field for the last twenty-five years. Nothing can be more helpful to teachers than knowledge of the facts and conclusions reached within this most productive period concerning memory, attention, association, habit, senses, muscles and will, psychic time, psychogenesis, the incipient neuroses so common in the school room, the momentous phenomena of adolescence, etc., but from cover to cover there is not a hint of a single one of these things. That a bright American teacher after studying pedagogy two years in Germany should call this little Herbartian primer a "great and good book," shows how far German pedagogues are behind the best in their own land and line, and how grievously American teachers who go abroad to study educational philosophy need competent direction where to go and what and how to study. That Herbartianism, the fundamental conception of which is that all psychic activity consists in working over ideas *(Bearbeitung der Begriffe)* should from its very completeness become so stagnant and barren is one of the ironies of fate. Yet despite its scientific cheapness and obsoleteness, this book will mark a distinct advance for teachers whose only philosophy of education is the current vagaries of Hegel, now so prevalent among them in this country, an advance, to be sure, made in Germany fifty years ago, but not yet very generally bettered by German teachers. The practical applicability of this standpoint and book makes its merit. It should be read and studied by American teachers for its own sake, for whom we trust it will prove a step toward very far better things for them, could the great resources of modern psychology be now made accessible to them.

Zahl und Verteilung der Markhaltigen Fasern im Froschrückenmark. JUSTUS GAULE. Abhandlungen der Mathematisch-physischen Classe der Königl. Sächsischen Gesellschaft der Wissenschaften. Vol. XV, No. IX, pp. 739-780, 10 plates. Leipzig, 1889.

Die Stellung des Forschers gegenüber dem Problem des Lebens. Rede, JUSTUS GAULE. Leipzig, Verlag von Veit & Co., 1887, pp. 24.

Der Oekus der Zellen. JUSTUS GAULE. Beiträge zur Physiologie, Carl Ludwig gewidmet. Published by F. C. W. Vogel. Leipzig, 1887, pp. 133-148.

The first of these papers, a monument to German patience, is the result of most painstaking work extending over a period of five years; and marks an important advance in our knowledge of the fibre relations in the frog's spinal cord. The condensation of the matter to a limit of forty pages, perfectly classified and arranged, together with full illustration by diagrams and plates, from which the paper may almost be read, form most commendable features of the work.

Dr. Gaule has actually counted the medullated fibres in cross sections of the frog's spinal cord at five levels. These levels are designated throughout the paper as 1, 2, 3, 4, 5; and are taken:— 1, at junction of cord with medulla; 2, through root of 2d nerve; 3, near origin of 4th nerve; 4, just below that of the 6th nerve; 5, below origin of 9th nerve. As will be remarked the levels occur at the anterior end of the cord, at the middle of the brachial enlargement, at about the point of greatest constriction in the dorsal region, through the middle of the lumbar enlargement, and near the posterior end of the cord. In regard to

methods employed, Erlyki's fluid, twenty-one days in the dark, at 39°, is followed by parafin embedding, making use of xylol instead of turpentine and clove oil. A perfect series is obtained, and this is stained by Weigert's haematoxylin. The counting is done by the aid of an ocular net micrometer; and since the section is too large for a single field, this is supplemented by a very exact micrometer stage. To insure accuracy in counting, the author employs the principle of bilateral symmetry. How well his work meets the requirements of this control is seen from the following figures.

	1. Section between medulla and cord.	2. Through origin of 2d nerve.	3. About 4th nerve.	4. About 6th nerve.	5. Below 9th nerve.
RIGHT.	28429	36707	21579	30141	8296
LEFT.	28245	37992	20246	30917	8017
Giving sum for different levels	56674	74699	41825	61058	16313

We are also favored with the number of fibres occurring in the different columns of the cord, as follows:—

Posterior columns,	R.	4862	8966	6345	13120	3030	6110	3998	7854	1659	3404
	L.	4104		6775		3080		3856		1742	
Anterior columns,	R.	7499	14881	9966	21566	4578	9098	7877	16091	2067	3814
	L.	7382		11600		4520		8214		1747	
Lateral columns,	R.	14701	29887	19131	36592	13134	25345	16478	33853	4354	8596
	L.	15186		17461		12211		17375		4242	
			53734		71278		40553		57798		15811

Comparison is made between the areas of different sections and the number of fibres contained in them, and this yields the interesting result that the brachial and lumbar enlargements are due to an increase of fibres at these points more than to an increase of gray matter.

Perhaps the most remarkabl econclusion which Gaule draws from his enumeration of fibres is a scheme of the arrangement of fibres in the spinal cord; by which, from the number of fibres entering by each of the spinal roots, he can easily compute the number of fibres in a cross section of the cord at any level. The notions underlying this, as we shall see later, are the ideas so characteristic of Gaule's work, the idea of a "*Chemischer Grund*" and that of the "*Oekus der Zellen*"; *i. e.*, of fixed numerical and quantitative relations obtaining throughout the structural as well as the chemical elements of all organisms. "A certain number of cells of one kind call for a perfectly definite and constant number of cells of another kind." Eggs do not divide hap-hazard into two, three, a dozen parts. But each egg segments in a definite and constant way into two, four, eight, sixteen, etc, This relation is said to be lost in the confusion of great numbers; but in general it holds good and can be revealed in any stage of the animal life by the proper methods. Hence a given number of fibres in a nerve root calls for a definite number of fibres in the spinal cord. These cord-fibres may be divided into three classes, designated by *a*, *b*, *c*.

a.—"Long fibres," which connect the central end of root-fibres with the medulla or some other part of the brain.

b.—"Medium fibres," connecting different regions of the cord.

c.—"Short fibres," which connect parts within the same region.

The author bases the theory of his computation upon seven propositions which are in substance as follows:

Prop. 1. Each medullated fibre in the cord is so placed as to function with one fibre of a spinal root.

Prop. 2. The medullated fibres of the cord form the connections of the root-fibres with each other and with the brain.

Prop. 3. We may divide these connections, according as they are made by the above long, medium, or short fibres, *a*, *b*, *c*, into three classes.

Prop. 4. ("Characteristic and peculiar to my theory.") To the central end of each root-fibre is grouped, in the cord, a definite and perfectly constant number of medullated fibres.

Prop. 5. The central ending of the root-fibres and the origin of the cord-fibres belonging to them do not lie far from the entrance of the root into the cord. (Proved by Birge's count of the elements of the anterior roots, and the simplest supposition for those of the posterior.)

Prop. 6. The length of the medullated fibres depends upon the distance apart of the elements which they connect.

Prop. 7. (Upon which his computation immediately depends). The central end of each root-fibre makes:— *A*, *two* connections with long fibres, one on the same, the other on the opposite side: *B*, *one* connection with a medium fibre, which ascends for the lower, and descends for the upper half of the cord; *C*, *eight* connections with short fibres, two which ascend, and two which descend for each half of the cord.

Taking now Birge's count of the root-fibres as the basis of computation, the number of fibres at different levels of the cord as computed and as actually counted, correspond as follows:

	Computed.	Counted.
Section 1	56,000	56,674
" 2	74,000	74,699
" 3	45,500	41,825
" 4	60,500	61,058
" 5	18,000	16,313

Of the forty pages, Dr. Gaule devotes twelve to an elaboration of his "purpose" in this investigation. And we learn from this that he is prompted to the work by the same ideas which animate his "Rede," ("Discourse on Science and the Problem of Life"), and his "Oekus [οἶκος, *Haushalt*] der Zellen," (household of the cells.) Hence the reference to these papers. From these we may obtain a key to Gaule's system. I cite them for this purpose and not with a view to giving complete abstracts from them.

In the "Rede" Gaule says in effect: If we knew all the chemical reactions, and all the physical forces which are present in the phenomena of life, we might still be no nearer the solution of the problem. May not life itself lie outside of these things, in groupings or combinations of groups of chemical and physical processes? To quote a few words: "These reflections have cooled the cheerful courage and high hopes of scientists who have turned toward the problem of life. Those who grasped most clearly the greatness of the task, were the first to doubt the possibility of its solution. I do not know what gives me courage to contradict them, but I cannot silence my hope. Let me tell you how I think the difficulties in the problem may be overcome." Innumerable as are the forms of living beings, certain common limits teach us that the processes throughout are in main features the same. And Hoppe-Seyler has already reached a general characteristic of all the processes taking place in living beings.

With the same chemical basis, why then, are not all living beings alike? Why are not all molecules which contain oxygen, hydrogen, and carbon, alike? Because different *processes* result indifferent combinations, different compounds, *i. e.*, different structural arrangements of the atoms.

These, which we may call higher combinations, make possible higher processes, to form in turn still higher combinations, and so on. As in terms of biology different physiological processes produce different morphological structures, vice versa, more highly developed structures cause, in a sense, higher physiological actions. These chemical processes must be in nature "cyclical," catalytic, resembling the action of ferments.

As Gaule expresses it at the close of the "Rede": "Life is cyclical, thus cause and effect must change about in it. As force is the cause of form so form is also the cause of force."

In the "Oekus" we find the thought developed a step further. He uses the word "Oekus" to designate an ideal organism in which the structures, organs, mediating these cyclical changes are linked in an unbroken chain. In imagination it is possible to trace, we will say, a molecule of food through each organ from one end of the chain to the other. The first organ receives it, makes use of it for its own life and excretes it, when of no further use to itself, in the form required by the next organ; and so on through the whole chain. This he attempts to illustrate in the organization of a frog and in certain cyclical changes which he has observed to take place in the formation of the blood. "The case is further complicated," he adds, "by the fact that every cell, while a part of the œkus, is after a fashion an œkus in itself."

The next step in the development of the thought we find expressed under the head of "Purpose," in the article first reviewed. It is the necessary logical consequent of what precedes in the "Rede" and "Oekus." "I make bold to assert," he says, "that the [numerical] relations obtaining between these elements, [of nerve, muscle, gland, etc.,] characterize absolutely genera and species." The purpose of my work is to supply a small link in the chain of evidence necessary to demonstrate this fact.

It is difficult to pass judgment upon the theoretical portion of Gaule's work. At present it seems to rest more upon analogy than upon fact. On the one side, the definite constitution of the chemical molecule he projects by analogy into the organization of living matter. On the other side, from the economy of the household he draws by analogy mutual relationship between the cells or lower elements of living matter. He cannot expect all to follow him on ground of analogy. Still Dr. Gaule has faced the problem of life in a manner which calls for no prejudice. It is true his "*Würmchen*" was ridiculed as a parasite of the blood. So persecuted they the spermatozoön and the white blood corpuscle before it. Prejudice and dogmatism may say what they please about such work. It makes little difference. The problem of life is too deep for either of them to solve. And it is quite possible, if we are ever to approach its solution, that we may be compelled to adopt new ideas of organization. No doubt, however, can arise as to the value of the practical portions of his work.

[C. F. HODGE, PH. D.

NOTES.

Observations on General Terms.

One hundred and thirteen school boys, between the ages of 13 and 18 were asked to write their first thoughts or mental images on seeing the words, *being*, *the infinite*, *literature*, *abstraction*, *number*, *play*, *coldness*, *horror*, *heat*, *faith* and *fun*. A word was written upon the blackboard and a few moments given the pupils to transcribe their impressions, when the word was erased and another written. A few minutes each day were given to the exercise, some days three or four words being given in succession, *number*, *play* and *coldness* happening to be given at one sitting.

Many of the images have the local coloring of the time and place. The boys had been studying Sir Walter Scott as their papers reveal, and during the week of the experiment the entire city of Boston was thrilled with horror by a suburban railroad disaster, the shadow of which is cast upon these papers, which also reflect the enthusiasm of the prize drill, the papers as a whole giving one the impression of a kaleidoscope where thoughts take the place of colored glass, the feelings regulating the symmetry of the forms.

Under *being* 44 wrote, human being, which may or may not have been an attempt to define; 18 wrote the name of the Deity under different forms; 8 wrote "something living;" 4 gave it as "our life;" 2 as human existence; 3 specifying Wallace, Adam and Blanche, myself, others giving general examples, as monkey, dog, horse, man and woman. If one could but know if the man were a warrior, the dog a Saint Bernard, the monkey a wild one in a cocoanut-tree or one caged in a zoölogical garden, or passing its scarlet cap for the organ-grinder's pennies — then the interest would be increased. Creation and something that cannot be limited were suggested, and one poetic mind gave us this: "I see a beautiful being over a baby's cradle, rocking him to sleep." A minute description of that "beautiful being" would be valuable. Six gave no expression to their thought about the word, which might have been from shyness about giving the thought to another, or a misunderstanding of the experiment and perhaps from a lack of any impression.

Under the word *infinite*, 29 directly named God, 1 love of God, none of these being of the seven who named Him under being; 21 gave no expression; 5 the algebraic quantity ∞; 5 the sky; 3 the infinite number; 2 the unknown; 1 the problem never finished, 10÷3; something dark; the future; number of wonderful things; number of boys; something beyond us; space; distance; a long line of which I cannot see the end; small thing; the universe; a large tree with infinite number of leaves; a sermon in which the minister said: God is infinite love; the air; time; city; a large man; the Globe building,—to this the boy added parenthetically, "infinitely large;" miraculous; everlasting; heavenly spirits; space; day; end of being; life after death; Venus on the sun; something to happen; form of verb; grammar; book entitled "Letters from Hell." No blanks were given with this word, but there were four under literature, a suggestive fact.

To 26, *literature* suggested books, some specifying good books, story books, etc.; 7 wrote reading; 3 history; 3 Longfellow; 3 Scott; 3 Waverly; Ivanhoe, Dickens, The Inferno, Shakspere, Homer and Milton, each having had honorable mention; 2 dime novels were suggested. Among picturesque thoughts appeared: A man printing a book; with literature comes sight of immense library with books of all ages and peoples; ancient Greece, especially Athens and old Greek tablets. A painting, funny composition, piles of papers, and something classical are as definite perhaps as some of the adult notions of literature.

Under *abstraction* there were 37 blanks: 23 attempted to define or illustrate, some of these efforts being too unique for omission, as: flavoring for icecream; flavoring put up in bottles; getting a tooth pulled; apples and baskets; spoke of a wheel; kindness and a man with head resting on hands, elbows resting on marble top table; a boy leaning on his hand and looking as if he saw something away off; sitting at a window in the country looking blankly into the air; a crazy person comes to mind; I picture a man in deep thought; works of nature especially beautiful scenery. Others wrote kindness, goodness, grammar, future, a wood, a beautiful sky, part of speech, an abstract person, something small, pleasure of having plenty of money, basket of flowers, and, this list of words about which I am writing.

Under *number*, 37 tried to define or illustrate; 15 wrote that it brought to mind various numbers as 1,000,000, 1,2, 10, etc.; 11 left a blank; 9 wrote figure or figures; 2 algebra. Limitation was twice suggested, and under the preliminary "it brought to my mind" or "it puts in my mind" were written: A row of blocks; a collection of men; the times I have been in swimming; the wonders of arithmetic, and No. 30 La Grange street. Others stated without explanation: the first page of an arithmetic, the score in a game of tennis, a number of soldiers, a lot of people on the fourth of July, sand in the sea, crowds of people in various places. One boy wrote simply newspaper, and another that number led to numerals. A connection was made by one between this and the two succeeding words. On seeing number I thought of a number of boys—think of them yet as I see play, and the same group appears to be playing, but growing cold toward each other. Three wrote unreservedly: I see a figure, I see a figure on the door; I see an unreadable number that I once saw.

Under *play*, 37 defined or illustrated, 5 left blanks, 1 of whom gave the most elaborate of the mental pictures under abstraction; 7 specified children, some designating little children, and kittens playing in various ways; 13 thought of base ball; 4 of a theatrical performance, 1 of these specifying Lady of the Lake; 2 thought of Richard the Third; 4 of lawn tennis; 3 of piano playing, 1 giving this: Play brings to me the figure of a person seated at a piano engaged in playing it. One wrote without preliminary: A large stage over which are some red curtains and a very small man declaiming. The vividness of this sketch leaves the bad construction of the sentence for an after impression. Three wrote: I see boys or children running round; I see the boys play; I see somebody playing.

Twenty-six defined *coldness*, the physical and spiritual significance being about equally represented; 26 thought of winter or a day in winter; 7 simply wrote ice; 5 gave blanks, others giving such picturesque details as these: A man with a very stern face; a large field of ice; a frosty ground with here and there a stump; I think of the look of coldness on the face of a high-toned boy toward his poorly dressed comrades; surly temper; anger; shivering; Greeley's expedition to the North Pole; proud person; firmness in a man; making a call on a young lady who is not at home; dressing myself in a big overcoat; not being sympathetic toward the poor; don't notice any of your parents; I think of unhospitality; associated with kicking the feet against the dash-board of a horse-car and an ulster with a high collar; Iceland; sharp cutting wind; I see the frost and snow; I see a cold and haughty person; dark gray objects appear.

Fifty-one defined *heat;* 5 left blanks; 3 thought of a stove; 2 of a furnace; 1 of a furnace for melting glass, and 1 of a smelting furnace; 1 of a register and another of a radiator, gilded; 1 of the school-house boiler room; 2 of summer; 2 of fire; 3 of the sun; 1 of the desert of Sahara; the others of parading around the city; a red hot ball rolling on the

floor; melted butter; anger; a day in East Lexington with buzzing of locusts, a fat man trying to get his breath; a large vat under which is a fire filled with saints.

Fifty-five attempted to define *faith;* 14 left blanks; 3 mentioned dogs; 2 wrote simply a cross; 1 a church; 1 a catechism; 1 a prayer-book; and others such typical subjects as Daniel in the lions' den, tableau once seen, picture of Faith, Hope and Charity; 1 thought of the Supreme Being, and another of an Irishman's exclamation. To 1 was suggested the water cooler on the common; to another the story of St. Elizabeth. One wrote this: Faith brings a figure of a child on a high fence, a person below trying to get it to come down, and then the child drops. Another gave this dramatic picture: A girl following a very ugly man through a dark tunnel. And still another: A frightened child clinging to its father for protection.

It was surprising to me that the word *fun* proved the least interesting of all, 8 even leaving a blank. I half suspect that these boys did not like to write their notions of fun, and so there were attempts to define, sometimes a game being mentioned as an illustration of fun. A smiling face, a laughing boy, and a girl laughing, were suggested; one boy writing, I see boys playing.

Fifty-two defined or illustrated *horror*, 8 of whom wrote simply murder, and 1 assassination; some left blanks, others wrote battle, death, fire, an avalanche, drowning, and battle; 2 only suggesting ghosts. It would be interesting to know whether each thought of any particular fire, death or battle. One wrote, I imagine a murder; another. simply, a picture of a man to be hung. Others as follows: a beer saloon; one being killed; the accident at Roslindale; a horrible looking word, looks as if it should be spelled hell; makes me think of seeing some one in distress; makes me think of some terrible accident; a woman and a mouse; a lady looking at an alligator; seeing a man run over here; a boy I saw stabbed, and another run over by a horse car; a fellow holding his hand in the air, his hair standing on end; an old lady holding up both hands; horror is represented by a man falling from a great height, and many people are watching him; horror brought to my mind a person dying who regarded death with horror; makes me think of the time I was chased; makes me think of the feeling I would have if a large spider were crawling over me; the feeling I imagine if I were drowning; I think of a robbery; something cringing; a train, a smash up with piercing shrieks; a woman standing with hands thrown back (from a picture I saw when a child); a dream of snakes I had five years ago; and this: I see a house on fire, a girl with long streaming white hair, dressed in white standing at a window with the fire all around her.

A picture of a window was drawn on the blackboard for the same boys and they were asked to imagine it a real window and to write what they saw in looking through it. These are the pictures seen:—A tree and some houses, I seem to see a man wearing an old felt hat. I am looking in the window of a small cottage, there is an old lady sitting in a large arm chair knitting; her young daughter is getting supper and all seems comfortable and cosy. Air, houses, trees. Darkness, Christmas tree, children playing, a procession, soldiers. Streets, people, horse-cars, and carriages. Light, people, I see a street covered with many persons, horse-cars, express teams, large buildings, etc. I see an old shoemaker pegging away at a laced boot. A lot of boys going home, a long narrow lane in the country with a pasture on one side and a pond on the other, a guide post and hills in the back ground, a green field in the country. A moon-light night, a large brick house and a tree. An old woman with a large dog that lives on the same street as I. I seem to see a beautiful house surrounded by trees and a beautiful lawn. A horse and team standing. When I look through the window I seem

to see a boy fishing in a river and he seems to be catching many fish. Through an imaginary window I can see a field at the bottom of which is a lake with boats on it and beyond is a green forest. If to a room, the form of the room and arrangements. Reminiscences: Looking out of that imaginary window I seem to see my mother scolding my brother. I would see some glass. I seem to see trees, a farm house, grass and cows and horses in the pasture and a barn in the distance. I see Mt. Washington and the Presidential Range in the White Mountains. The boy who was run over by a horse-car and his arm badly crushed. I saw a man fall down. A procession of boys marching along. The scenery from a window looking toward Mt. Washington. The man selling lobsters. A palace court yard. Engine going to a fire and a crowd following it. I seem to see a black substance through the window. The sky. Makes me think of the faces at Blackwell's Island, looking earnestly at the Boston boat. A criminal behind a prison door. A dark stormy night. I see a face, it is a sad one with large eyes which have evidently been crying; it is a girl's face with a charity cap on. A train rushing along, filled with passengers. A landscape. I see a face through this window. It appears to me like a look out on to the world. A game of foot-ball. A horse-car loaded with people going down the street. A field. A woman sewing. I see the future. I see a horse and team passing. Transparent. Distant hill. A dungeon. Trees, fields, spring, horse-chestnut tree. A hill covered with snow and a few bare trees. Makes me think of seeing some one in a window. A large room with fine things in it. Soldiers. Empty room. Friend. Nothing in particular. The state of Illinois. I saw some houses through the window. I see the trees and houses as I look through the window. Stars. I can see green fields and the ocean with a light-house on a large rock in the middle of it. A railroad station. I am in a farm house on a farm and looking upon the corn field and a few trees. Some trees. A lawn enclosed by a fence with a fountain in the center. I see a house in the distance. Sky, trees, houses seem to be the only panorama of a window. I seem to see a blackboard. A room. Saw a regiment of soldiers passing. I see a large house, square and brown. A dog fight on Columbus Avenue. A comfortable room. I see an evening sky full of stars. I see the dog outside. Looking at a picture I think of what it is of, where it is, and who was engaged in it. A steamboat passing down stream. Seeing a sight through a window which never can be forgot, either of horror or pleasure. I see a young man. It reminds me of the garden, a bed of geraniums at the house I lived in when I was in Germany. Looking at a boy. A scuttle of a sinking ship. One would see as if painted on a panorama before him from childhood to old age. I see through this window the ocean with about fifty yachts sailing. A tree and some houses. I see a child running across the street, a team is coming, and the child is knocked down and killed. A lamp post. A boy fishing.

Eight boys drew a blank, and several of them drew pictures of windows on their own papers.

Such meagre data as the above show that those who disparage "mere sense knowledge" disparage children, who up to these ages show few traces of any other kind of knowledge, but think mainly in visual pictures, their mental life being chiefly made up of imagination and memory of their personal experiences. Logical definitions are never attempted. A true psychological definition of such terms could be got by greatly increasing the number of such returns and presenting the results by graphic, statistic and descriptive methods. If anywhere constant appeal from the individual to the general consciousness is constantly needed, it is in the realm of abstract and general terms. If a carefully selected set of terms in the ethical field could be selected and

returns gathered thus and separately for different ages and sexes, valuable results might be expected. It is interesting to compare such results as are presented in the case of the imaginary window with those described as "crystal-vision," reviewed in this number of the JOURNAL.

Francis Galton in some studies of this nature, but on adult minds, makes a table of results from which he draws this conclusion: "Hence we may see the greater fixity of the earlier associations and might measurably determine the decrease of fixity as the date of their formation became less remote." The city teacher more than any other needs to grasp this law, and give the children an early and vivid outlook upon nature; walls and horse-cars, pavements and engines are so likely to demand the attention of children that no opportunity should be lost to give a glimpse of the sky or clouds; to turn the thoughts to a grass plat or even a grass blade and so open the windows of the soul in the direction of influences which will accelerate the growth of intellectual and spiritual life. S. E. WILTSE.

Under the title of "*Die Eigennamen in der medicinischen Nomenclatur*, Dr. Med. Richard Sy has collected some 600 proper names as applied in medicine, anatomy, and some other branches. Each entry is followed by a short definition and sometimes a line regarding the person whose name is entered. The list as a whole must be useful, but in detail is open to criticism so far, at least, as the neurological terms are concerned. For example, the Deiter's cells of the central nervous system are not mentioned, and the definition of the foramen of Monro is irrelavant.

The American Journal of Insanity, for October, 1889, contains a paper read by Dr. H. E. Allison, Superintendent of the State Asylum for Insane Criminals, in Auburn, N. Y., at the Newport meeting of the medical superintendents this year. He advocates a general system of reporting autopsies in our asylums, and gives a "form for post-mortem records." One side of this contains blanks to be filled in with the most necessary data, and the other has four outlines of the brain from Ecker, (dorsal, ventral, mesial and lateral aspects), on which any superficial lesion can be directly recorded.

The dangers of the psychiatric calling are presented in a laborious report just published by H. Lähn in Berlin. The average age of death of 431 alienists was 57.81 years, which is very low compared with the average age in other branches of the medical profession. Of 162 alienists, the cause of whose death is known, 7 were killed by patients, 10 fatally injured by lunatics, 6 committed suicide, 11 died of slow brain diseases, 17 of apoplexy. In all, 42 per cent. are thought to have died from causes directly or indirectly arising from their vocation.

The long discussion concerning the recognition of partial or reduced responsibility for criminal acts in the penal code in Germany seems likely to issue adversely to the proposed rubric. That there are many border-line cases which deserve neither acquittal nor the full penalty, is admitted, but the practical difficulties of adjudicating such cases in the face of the general incompetency of both jurists and physicians, are thought to be decisive against this class.

In a careful study of the effect of imprisonment on insanity, Kirn (*Berlin. klin. Wochenschrift*, 1889, No. 33), shows that confinement has a very strong tendency to bring out hereditary taint; that there is commonly immunity if the first six months are endured without morbid symptoms; that collective imprisonment tends to chronic and slowly unfolding diseases, while isolation causes acute psychoses with especial prominence of sensory hallucinations.

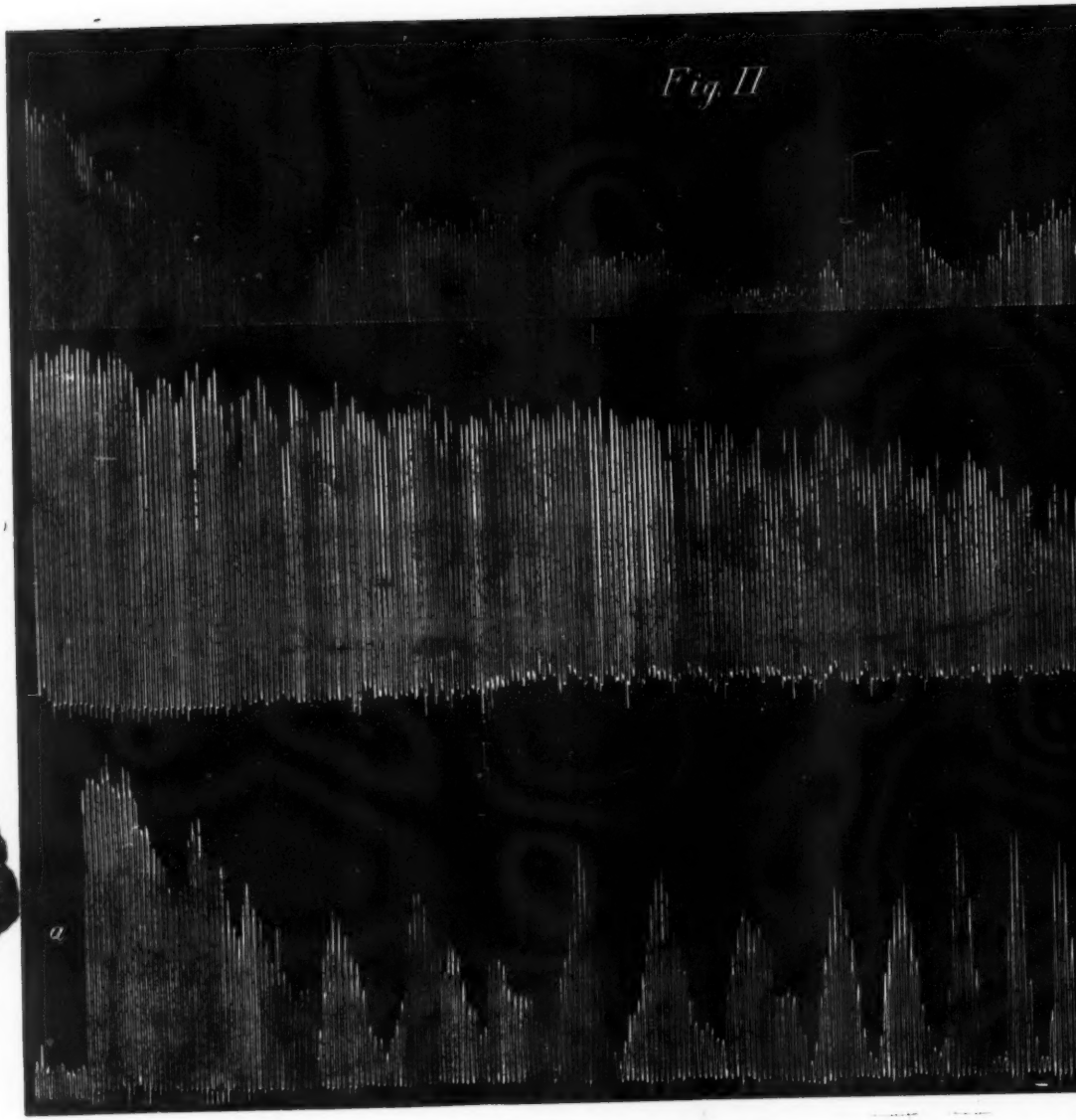


Fig. II
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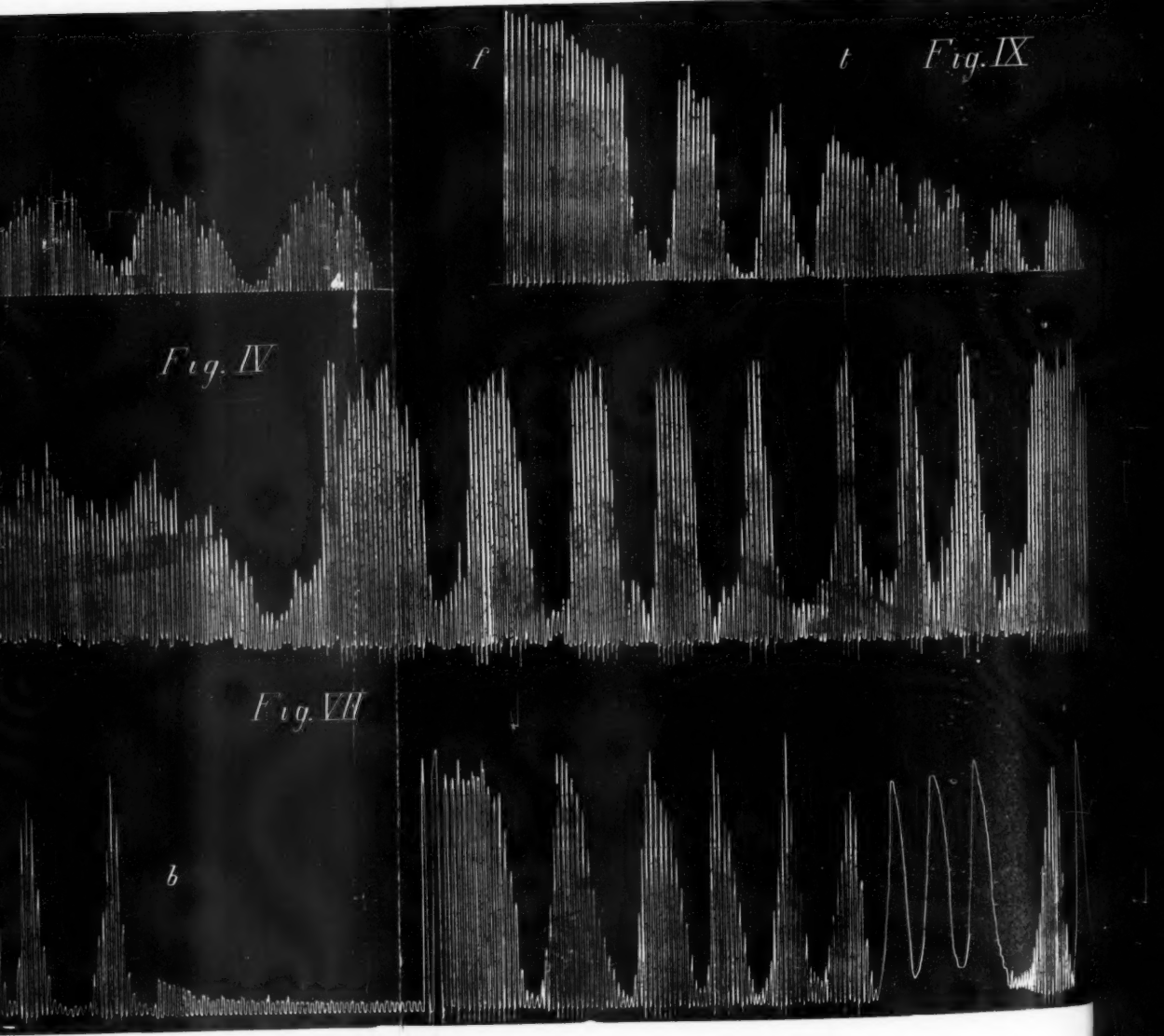

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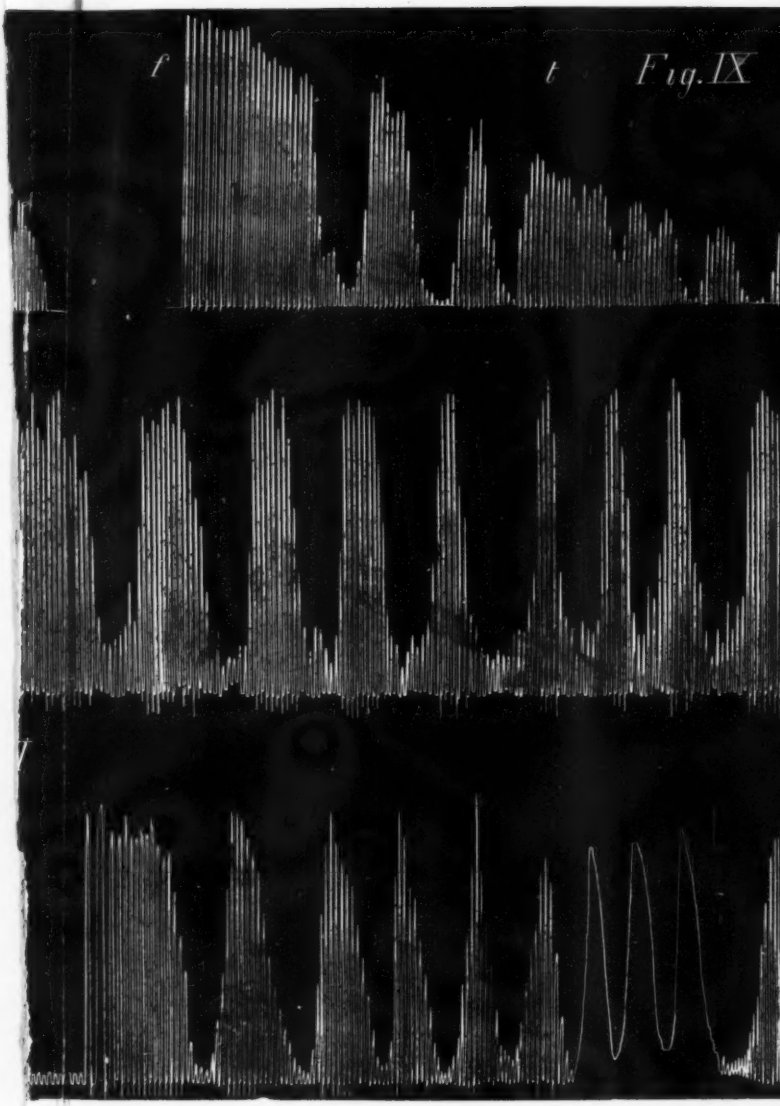

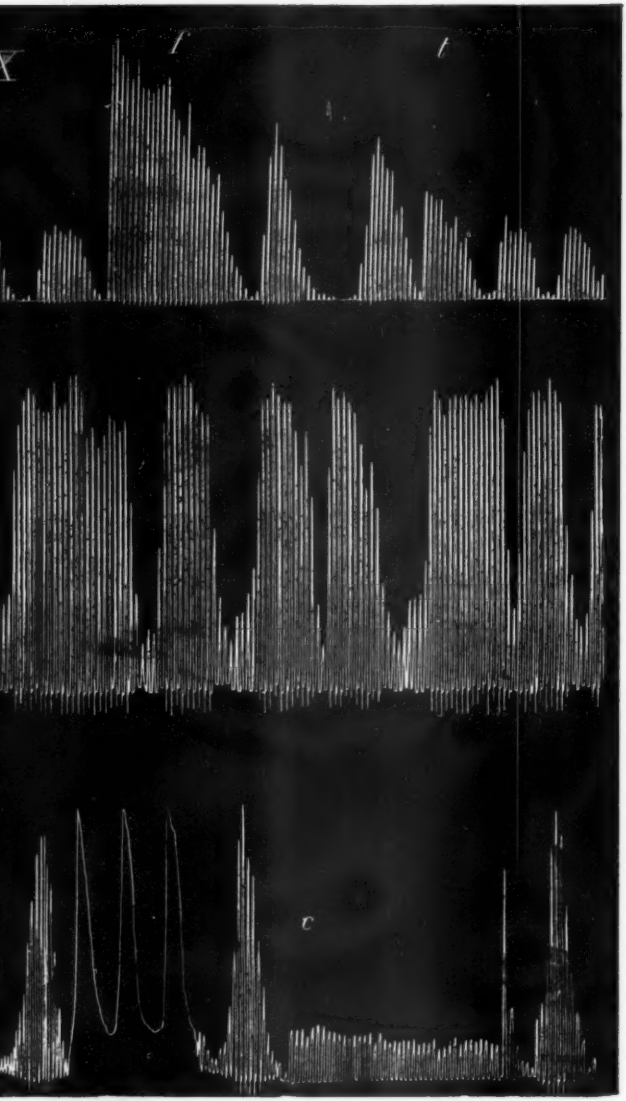
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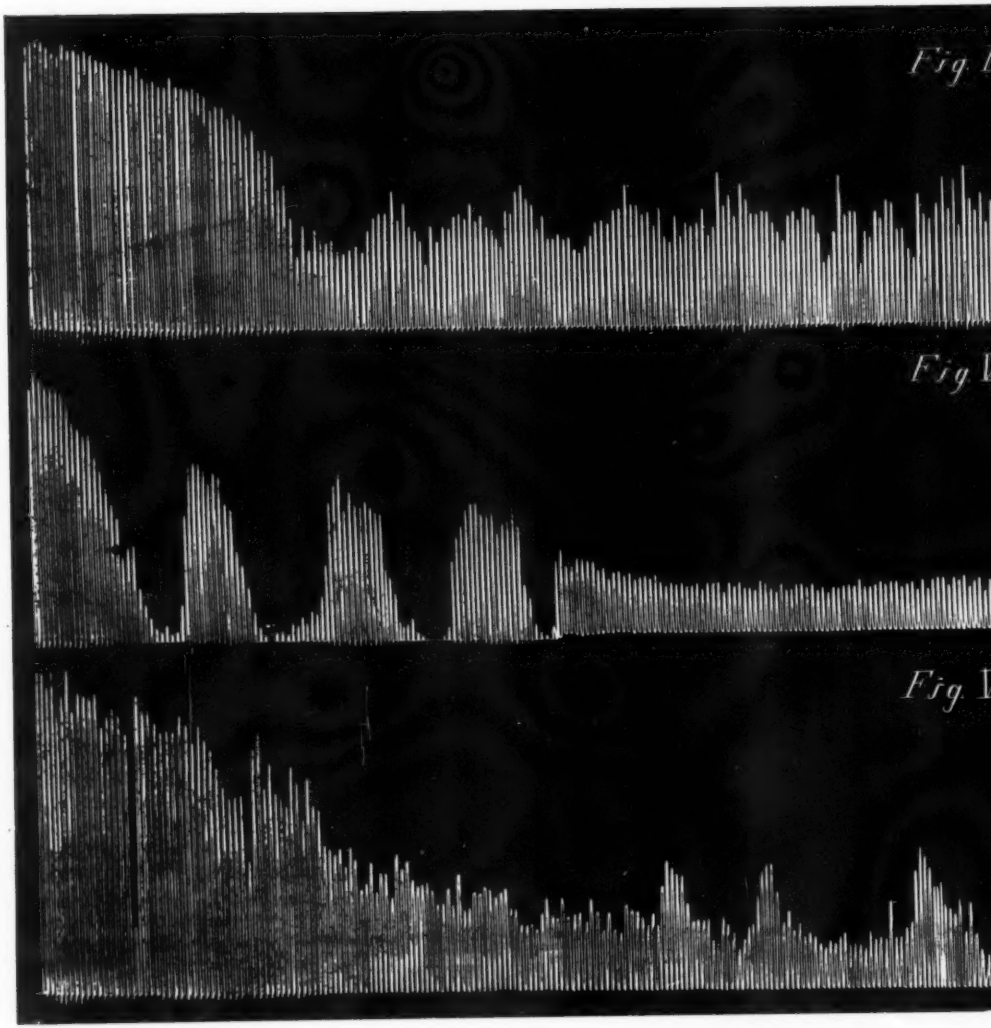

TE II.